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WEST EUROPE REPORT: SCIENCE AND TECHNOLOGY

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18 June 1984

WEST EUROPE REPORT

SCIENCE AND TECHNOLOGY

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FRENCH, JAPANESE FORM CARBON FIBER FIRM

Paris LES ECHOS in French 6 Apr 84 p 8

[Article by J. J.]

[Text] Georges Besse is a real sly character. He pretends to disappear here so as to reappear elsewhere. A real industrial "Scarface." Around the end of 1983, he left Hercules, breaking an agreement he had signed in 1981 with the American number one in carbon fibers. Everyone thought Pechiney had decided to concentrate entirely on aluminum and copper, reducing to a minimum its interest in composite materials.

This impression was further strengthened when the nationalized firm hinted that by adding a pinch or so of lithium to aluminum an alloy could be obtained capable, in particular, of yielding a 15 to 20 percent weight reduction in a plane. An alloy, therefore, able to compete directly with carbon fibers. Well, peek-a-boo! Pechiney has turned up again, but this time with ELF [Gasoline and Lubricants of France] and Toray of Japan.

For, while Georges Besse believes firmly in the future of aluminum alloys, he cannot ignore the fact that the automotive, defense, aeronautics and leisure industries are already at the threshold of the composite-materials generation, with carbon fibers in the dominant position. And this, even though European consumption looks far less promising at this stage than anyone had ever expected.

ELF is providing Georges Besse the vehicle for his surprising return. A return facilitated by a commonality of ideas between two state-owned enterprises, ELF and Pechiney. And apparently, by an old-buddy relationship between the former officials of the AEC [Atomic Energy Commission], Michel Pecqueur, now head of ELF Aquitaine, and Georges Besse, both , if it might be said, of the Andre Giraud school.

It so happens that the minister of industry, in particular, wanted France to loom large in composite materials, which, in time, are going to revolutionize the structures and production methods of products.

The Crucible of the Marketplace

Owing to its good relationship with ELF Aquitaine, Pechiney offers a protuberant balcony overlooking this new world, with 50 percent of the capital ownership in the new firm, which will retain 65 percent of the shares previously owned by ELF Aquitaine in its association with Toray. The Japanese group will hold a 35-percent ownership in the SOFICAR [expansion unknown] firm, which it formed originally with the French petrochemicals firm.

A form that is building, at Abidos in the Pyrenees-Atlantiques, a plant to produce carbon fibers, with a capacity of 300 tons a year. This plant, which is now under construction, is scheduled to become operational in 1985, and will employ some 100 persons.

Toray must be happy to have indirectly slowed Hercules's momentum in Europe. But the French have not come off too badly in this composite materials "triangle," which now has to submit its technological prowess to the crucible of the marketplace--by infiltrating tomorrow the domains of the aircraft jet engine, the helicopter propeller blade, the Airbus fuselage, the tennis racket, the ski and the missile nose cone.

9238
CSO: 3698/419

GLASS, CARBON FIBERS MADE AT FIBRE ET MICA IN FRANCE

Paris INDUSTRIES ET TECHNIQUES in French 10 Apr 84 pp 34-35

[Excerpt] For the fabrication of composite material structures, the most universally used and cost-effective technique is the filament-winding process. Fibre et Mica, at Villeurbanne, has been using this method for some 20 years now. In 1962, it fabricated the structures of the Diamant rockets. Since 1976, it has been making the structural cores of the M4 missile propulsion systems carried aboard missile-launching nuclear submarines. Meanwhile, glass fibers have given way to carbon and "aramide" [synthetic] fibers.

As a part of the Alsthom group now, the firm is looking further ahead. "We have the necessary experience and machines to find civilian applications for composites. This time, we will be going up against aluminum," says Gerard Perez, in charge of fabrication of these materials. "We are now capable of selling glass and epoxy fiber tubing at the price of aluminum."

The venture is a difficult one for this company of 240 persons highly specialized in military and space applications, where performance counts more than cost. "Thus far, we have sought to penetrate civilian markets with military profit margins. That has proven to be unfeasible. This time, we are equipping ourselves to produce, on a semi-continuous and automated basis, small-diameter tubing for electrical insulation. It is a market that can absorb several million pieces annually." At one time, Fibre et Mica had gone into laminates, with Celamine competing against Formica. This fabrication was abandoned in the early 1970's.

The firm is fully equipped to make any and all bodies of revolution: Eight winding machines, starting from glass-fiber rovings, carbon-fiber rovings or aramide-fiber rovings; thence, cylinders 6 meters long and 2 meters in diameter. Six impregnators, two of which are dedicated to the production of unidirectional-carbon-fiber sheets. "We want to specialize in top-of-the line composites," Gerard Perez continues. That is, a family of materials that encompasses at least 70 percent of reinforcing fibers. Applications abound wherever weight is a constraint. "In space, carbon fibers are irreplaceable. Even at 400 francs a kilogram."

For Nozzles, Brake Discs,...

All these installations were made initially for defense needs. The winding, impregnation and fabrication of carbon fibers were made French operations during the 1960's, based on the technologies of the American specialist firms Narmco and Hitco. Fibre et Mica are thus the sole French producers of carbon fibers for thermomechanical uses. Combined with a phenolic resin, they are used for the fabrication of heat-resistant components in aeronautics: Nozzles, brake discs. In this regard, their application also extends to missiles and Mirage 2000's. Very soon, however, these top-of-the-line composites will find a civilian application: The brakes of the Airbus A 310. Formula 1 racing-car brakes also make use of this material, which, for equal weight, absorbs twice as much energy as steeel.

Carbon fiber and graphite fiber of this type are fabricated from two precursors: PAN (polyacrylonitrile) and rayon. The PAN rovings (supplied by Courtaulds) are first drawn hot (150°C) and oxidized a first time. After weaving by an outside vendor, they are subjected to a second carbonization at 900°C, which releases hydrocyanic acid that is recovered and recycled. "This is not yet entirely pure carbon." A final calcining at 1,600°C (2,200°C for graphite fiber) yields a finished carbon fabric ready for impregnation with phenolic resin. Present capacity is a modest one: 15 tons a year for a product used in homeopathic quantities. "If a new TGV [high-speed transportation system] program were to be introduced, it could be equipped with carbon-fiber brakes." This fabrication is a 50/50 joint venture between Fibre et Mica and SEP [European Propellant Company].

Unidirectional Sheets and Carbon-Carbon Structural Rods

Carbon is also used in the fabrication of unidirectional sheets and of rods for tridimensional structures. Unidirectional sheets are used especially in aeronautics. There is just one type-approved base fiber: The T 300 made by the Japanese firm Toray, the world's largest producer and now associated in France with ELF [Gasoline and Lubricants of France]. The spooled rovings are layered, impregnated and pressed on to a flexible backing (silicon-coated paper) 300 mm wide by a specially-designed machine (Hot Melt Coater). Thicknesses vary between 50 and 200 microns.

Another rare specialty is carbon rods. These are solid cylinders 8 or 10 mm in diameter, consisting of between 80 and 90 percent fibers and the rest phenolic resin. Tolerances are held to 0.05 mm. These rigid rods are used for the fabrication of "lattices" that are then densified in an autoclave. This is a unique product, produced on a small scale by craftsmen, used for the fabrication of missile nozzles (by SEP at Bordeaux).

Filament winding represents one-third of Fibre et Mica's activities. Glass, carbon, Kevlar, all fibers are used, alone or mixed. "Everything considered, glass is still the material with the brightest future. It has

excellent fatigue strength. Its higher density is offset by its lower price." This process is ideal for all bodies of revolution: Tubes, spheres, cones, rings. Certain components consist of three superposed windings of different fibers. Thus, a thruster 200 mm in diameter contains, first, a carbon-fiber fabric applied manually, then a unidirectional glass-fiber sheet, and finally an outer fabric of Kevlar. "As long as the composite contains less than 40 percent fiber, there is really no problem of know-how. Practically anyone can produce it. But if excellent mechanical properties are required, the proportion of resin must be reduced to 20 percent," said Gerard Perez.

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PECHINEY JOINS ELF-TORAY TO PRODUCE CERAMICS, CARBON FIBERS

Paris L'USINE NOUVELLE in French 17 May 84 pp 57-58

[Article by Alain Pauche: "Carbon Fibers: Pechiney Is Reducing Its Risks"]

> [Text] Pechiney gave up its joint venture with Hercules, but it is cooperating with Elf and Toray: to gain recognition as a world producer, Pechiney is playing it safe.

European marketing prospects for carbon fibers are improving. In 1984, Robert Rager, chief executive officer of SOFICAR (the Carbon Fibers Company created by Elf-Aquitaine and the leading world producer of carbon fibers, the Japanese company Toray), which Pechiney has just joined, is counting on a 350-370 ton market. Somewhat reluctantly, he ventured estimates of 500 and 600 tons respectively for 1985 and 1986.

Robert Rager's caution is justified: in 1982, the market reached hardly 100 tons; it rose to 140 tons the following year, to 220 in 1982, but only to 260 tons in 1983. "After experiencing growth rates of 40 percent, we suddenly dropped to 20 percent," the head of SOFICAR explained. The main reason for that was that the aeronautical industry, which uses approximately half all the carbon fibers produced, went into a slump.

The "quiver" that ran through the market should not be mistaken for a recovery. Otherwise, how would Georges Besse, chief executive officer of Pechiney, explain his decision to give up the contemplated production (under a Hercules license) of 200 tons of carbon fibers per year, which was to start later this year at Pont-de-Claix near Grenoble? The Pechiney-Hercules venture started in 1982, soon after Elf-Toray had agreed on a competing project, and it was abandoned a few weeks ago, just when the production equipment--most of which had been purchased in the United States--was about to be installed.

Pechiney's sudden disinvestment is largely due to the fact that prospects for this market are now far less fabulous than they used to be, but that is not the only reason: "On this emerging market, the two competing French companies were hurting each other," Richard Armand, head of the metals and new materials division of Pechiney, told L'USINE NOUVELLE. "Together, the two French projects had a capacity of 500 tons, and two other contenders,

Courtaulds and Enka, were displaying far greater ambitions. As Hercules, our partner, had only a small share of the European market, that share had to be increased rapidly." Point by point, the head of Penchiney's metals and new materials division explained a decision that was not always well understood.

Actually, several weeks went by between Pechiney's decision to give up and its announcement that it was joining Elf-Toray... How could a supplier of the aeronautical industry (which accounts for 10 percent of the group's sales), a leader in the field of advanced materials such as titanium, zirconium or tungsten, reverse its position so suddenly? "Our job is to develop semi-finished products for new advanced applications," Richard Armand answered. "But not at any price! We had decided to be a leading world producer of carbon fibers, we had good relations with Elf, and Toray is a leading producer of fibers: the best we could do was to join SOFICAR."

The competition between Elf and Pechiney is over even before it started. The SOFICAR plant now under construction at Abidos near Lacq, which will employ 90 people, will start producing fibers from raw materials imported from Japan only by mid-1985. Until then, it will continue to market Toray fibers, which supply about half the European market. From now on, the risks will be shared by Elf and Pechiney, 50-50 partners in a holding company which itself owns a 65 percent interest in SOFICAR,the balance being held by Toray. Cost of the Abidos project: 160 million francs, including one third for the process.

As for the Pont-de-Claix plant, it was just sold to a Pechiney subsidiary, the METAFRAM [French Powder Metallurgy] Sintered Alloy Company, the latter wishing to bring its operations closer to industries that could complement its technologies (especially with respect to powder metallurgy). Still, Pechiney's decision will cost it 30 million francs, a lot less than it will cost Hercules, although the latter agreed to an amicable partition.

The industry and the Ministry of Industry agreed that two producers may have been all right in the 1970's, but not any more now. We should beware of definitive pronouncements. By the end of the decade, this opinion may have changed again. Especially if carbon fibers, which can be worked like a fabric and associated to many other materials, become part of "the industry's way of thinking," as Robert Rager put it.

A Dream-Market For World Producers: The Automobile

For the SOFICAR chief executive officer, the development of carbon fibers, a material with a high tensile strength and a low density, is not hindered by its costs but by "the understandable intellectual inertia" of design and engineering departments. "We must reason in terms of function, not in terms of parts," Richard Armand added: "We can use carbon fibers to make a torsion bar for heavy-duty trucks and save the universal joint. It will be lighter, as resistant and more economical than metal."

World producers of carbon fibers are dreaming of the automotive market. But at 250-450 francs/kg (up to 1,500 francs for special fibers), fibers obviously cannot compete with steel. The markets for composites are necessarily small

(aeronautics and sports equipment in the case of carbon fibers). In addition, they are not obvious. Therefore, they require sophisticated and costly marketing methods. The same is true of research and development. Since carbon fibers are perceived as complementing rather than competing with aramid (Kevlar) fibers and metals that can be used as matrices, laboratories will increasingly be asked to develop new applications. Elf, an oil company that became a major chemical company, and Toray, essentially a leading textile company, thoroughly understood how interesting Pechiney was in this respect, as it has key positions in aluminum, zirconium, alloys and ceramics, and knows the markets better than anyone else.

This is why carbon fibers were incorporated to the Pechiney division headed by Richard Armand. It has sales of 1 billion francs and consists of six "trades": fabrication of titanium and zirconium (Cezus), molybdenum and tunsgsten (Cime Bocuze), ceramics (Cegram, Desmarquest) and carbon fibers. That is Georges Besse's way to link the interest of materials deemed vital for the future of a group that derives 60 percent of its sales from aluminum.

Japan As a Leader

Leading World Producers of Carbon Fibers
(1983 Figures)

Firms	Countries	Annual Production Capacities (tons)
Toray	Japan	1,200
Toho	Japan	600
Mitsubishi Rayon	Japan	100
Asahi Nippon Carbon	Japan	100
Hercules	United States	400
Union Carbide	United States	200
Celanese	United States	200
Hitco	United States	100
Courtaulds	Great-Britain	200
SOFICAR	France	300 (forecast)
ENKA	Germany	200 (forecast)

Source: Elf-Aquitaine and L'USINE NOUVELLE

The carbon-fiber market is dominated by Japanese producers. With a production capacity of 2,000 tons per year, they cover 65 percent of the world requirements. Toray, a leading textile manufacturer, is the leading producer worldwide and the leading European supplier. The only British producer, Courtaulds--another leading textile company--is manufacturing carbon fibers designed essentially for the sports equipment industry. The strategic

significance of this production is obvious and enough to explain the competition between French companies that just ended: the French aeronautical industry represents 30 percent of the European carbon-fiber market! The first production unit of the SOFICAR plant will increase the European production capacity by 5-12 percent, enough to cover all the demand (or even to exceed it if we include Enka, the subsidiary of the Dutch company Akzo, which is planning to produce 200 tons of fibers per year in the FRG).

9294
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FRANCE, OTHERS INCREASE SILICON PRODUCTION CAPACITIES

Paris LES ECHOS in French 26 Mar 84 p 10

[Article by Jacqueline Mattel: "Chemical Companies are Increasing Silicon Production Capacity"]

[Text]

Like some international chemical companies, Rhone-Poulenc has discovered its vocation in producing silicon. Projects being mentioned in the field of photoelectricity (see LES ECHOS of 9 March) also have electronics applications.

Rhone-Poulenc will produce the basic material: a very pure polycristalline silicon. In the first half of the year, the Rhone-Poulenc group is to decide on the construction of a new production unit. Its planned capacity is a modest 100 metric tons a year at the outset. The proposed site (but this has not yet been confirmed) is in the Rhone-Alpes region.

The basic material will be made into ingots and then into slices of monocrystalline silicon (electronic quality) by Rhone-Siltec (a partnership formed last year with Siltec, a U.S. company) in a factory that is planned for construction in Mantes.

The material can also be sold to Photowatt (CGE-Elf [Elf General Electric Company]) in polycristalline form for solar-power uses.

The French chemical company is thus following in the footsteps of Monsanto or Hoechst, whose subsidiary Wacker supplies 39 percent of the world market. The primary producers of polycristalline silicon are Wacker (in the FRG), Dow-Corning (in the United States), Osaka Titanium (Japan), Texas Instruments (United States), Dynamit Nobel (Italy), and Monsanto (United States).

Most of these (except for Dow Corning) are engaged in activities that use the silicon intended for electronics purposes (e.g. semiconductors and discreet power components). The leaders in this area are the Japanese company Shin-Etsu, the German company Wacker, and the U.S. company Monsanto. Monsanto is considered to be the number one company worldwide in producing silicon chips for the integrated-circuit industry.

With the entry of Rhone-Poulenc into the field, plans are growing for the production of silicon in Europe. The Japanese company Shin-Etsu recently announced a new plant in Scotland. Monsanto closed a unit in Belgium in 1979 but is now studying the possibility of one in France (also in the Rhone-Alpes region) or in Great Britain. In this case, too, the decision is to be made in the first half of 1984. Mightn't Europe have to face the prospect of overproduction?

Americans and Europeans estimate that polycristalline silicon production comes to 3,200 metric tons worldwide: 50 percent in the United States, 20 percent in Japan, and 30 percent in Western Europe. It should be noted that the Japanese have been talking about a production capacity of 6,000 metric tons. In any case, the situation is changing rapidly: new units (with a capacity of 1,000 metric tons each) are being built in the United States and Malaysia. Participants in these projects are Union Carbide, Monsanto and Shin-Etsu.

Silicon consumption (98 percent for electronics) is distributed thus: 48 percent in the United States, 27 percent in Japan, 23 percent in Europe, and 2 percent in Southeast Asia. Europe is a net exporter; the United States imports from Europe but exports to Japan, which is a net importer.

At the moment, demand is slightly higher than supply, and experts think it will grow rapidly in the coming years. Producers are thus confident that new production capacity in Europe and elsewhere throughout the world will find its outlets.

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BRIEFS

NEW POWDER METAL PROCEDURE--The processing of powdered refractory metals, such as titanium, zirconium, tantalum and niobium, makes use of complex, discontinuous and generally costly procedures. The Extramet company, at Annemasse, has introduced a simpler and less costly technology, based on germination of the metals in a molten-salts bath. It is applicable also to the processing of composite powders such as titanium or vanadium carbides. In the processing of powder titanium, for example, the salt bath is a solution of calcium in calcium chloride melted at between 600 and 800°C. Liquid titanium chloride is injected into this bath, where it undergoes a reduction yielding pulverulent titanium, which is separated by decantation. The same principle is applied to metals whose halides are liquid or gaseous. The procedure, the feasibility of which has been verified, will shortly move into its pilot-plant stage (several kilos of powder per day) to refine the techniques required for its industrial use on a continuous basis: Injection of the liquid solutions, decantation of the powder metal, etc. One of the advantages of the procedure is improved control of granule-size and purity of the powders obtained. The latter are used in powder metallurgy. [Text] [Paris L'USINE NOUVELLE in French 3 May 84 p 7] 9238

FRENCH FIBER RESEARCH--Pechiney plans to enlarge the line of technical-grade ceramics of its new subsidiary Desmarquet, recently acquired from Lafarge Refractaires. The ceramics involved are of the non-oxide type, and mainly those of the silicon-nitride and -carbide types and aluminum-silicate types. As regards silicon-carbide fibers, a complete reappraisal of the situation is under way. The view at Pechiney is that these fibers are at the stage of carbon fibers 12 years ago... prospects galore, but very few near-term industrial demand. Decidedly, Pechiney is not sold on fibers. SEP [European Propellant Company], on the other hand, which was associated with Lafarge in a joint GIE [economic-interest group] plans to continue, alone if necessary, its research on silicon-carbide fibers. [Text] [Paris INDUSTRIES ET TECHNIQUES in French 10 Mar 84 p 8] 9238

CSO: 3698/419

NEW VOLVO BODY PLANT THOUGHT TO BE WORLD TECHNOLOGICAL LEADER

Oslo AFTENPOSTEN in Norwegian 30 Apr 84 p 13

[Article by Ulf Peter Hellstrøm: "Volvo Introduces Robots"]

[Text] Göteborg, 29 April. Ninety-six heavy-duty industrial robots are the kingpin of the Volvo firm's new 60-million-kroner auto body plant which has now been put into service at the Torslanda Plant outside Göteborg. From here auto bodies go to other parts of the large factory complex or to production facilities in Kalmar, Belgium and Canada. Robotization of auto body work is an element of the big investment program which Volvo is involved in and which will cost 20 billion Swedish kronor to 1990.

Both the head of the Torslanda Plant, Göte Lindström, and others in Volvo's management believe that the auto body facility which the automobile firm has now put into service is the world's technological leader. The 600-million-kroner investment is the largest single project which the company has carried out hitherto in building up its production of autos of the 240 and 760 series.

The heavy-duty industrial robots at the facility are used to weld the newly formed panels together into a complete automobile body. Ninety-eight percent of all welds are performed by robots and automatic welding machines. It is above all the dull, monotonous job tasks which the robots have taken over from human labor.

The plant facility outside Göteborg is a sign that Scandinavia's largest industrial concern is under full steam in a production plan where robots and various forms of automatic machines are included as an essential component. The concern has used robots for about 10 years now. While such equipment is still used to a predominant degree in welding work, in Japan, the USA, in the Asea company in Sweden and, for example, at the Norwegian Trallfa factory, technological development is going in a direction whereby robots are to an increasing extent becoming able to handle more complex work operations. When robots are able to take part in difficult assembly and handling routines, this equipment will become even more widespread.

The Volvo firms itself emphasizes that robotization of production facilities is taking place not only for reasons of the pressure of costs and the desire for improved productivity, but also to give employees a more meaningful and

varied job. The robots will perform routine operations which demand monotonous precision of fractions of a millimeter.

At the new auto body plant employees are split up into production groups numbering about 10 persons each. Each group has total and complete responsibility for operations within its area. This is true also of requirements for quality and economy. Group members alternate job tasks, which range from production work to servicing and maintenance of the machinery and robots, inspection, issuing stock, and other things. The advanced technical equipment places great demands on the educational level of employees. The plant employs about 200 people. This is not many when one considers that the facility must weld together 200,000 auto bodies in the course of a year.

In other areas of production, too, computer-based facilities are emerging as a component of the eternal effort for improved productivity and quality. Two American DEC minicomputers are being used to control the production of series 240 and 760 automobiles, which are being produced in 8000 versions. The autos differ with regard to external paint, interior, the levels to which they are equipped, engines, rear axles, etc. Computer equipment is being used in the receiving department in order to keep track of the many auto parts from 600 suppliers in a good 20 countries which are necessary in order to maintain a proper structure for production. The control of materials, shortterm planning and longterm forecasts also take place by means of these facilities.

Volvo has plans to station computer terminals with its big subcontractors within or outside of the concern, which are to be connected directly to the company's big computer facility. This will take place next year at the earliest. One of the candidates is without doubt Raufoss Ammunition Factories, which supply, among other things, bumpers for Volvos.

The big Torslanda Plant manufacturing facility outside Göteborg is now 20 years old. The first investment of 240 million Swedish kroner was the biggest industrial investment in Scandinavia up to that time. Now the Volvo facility has experienced improved productivity of an average of six percent per year for the past five years. The company has, in addition, a system of quality bonuses for employees, which are paid out two times a year. Five percent of the personnel budget is earmarked for quality control tasks in connection with auto parts and the production process.

8985
CSO: 3698/429

AUTOMOBILE INDUSTRY

EUROPEAN FIRM HAS PROTOTYPE PLASTIC BATTERY

Paris INDUSTRIES ET TECHNIQUES in French 10 Apr 84 pp 140-141

[Article by Philippe Le Coeur]

[Text] A battery that would no longer depend on the use of lead as its principal component, but rather on doped plastics, has been the dream of researchers. After numerous evolutions--active substances, external aspects,... --batteries are on the threshold of a revolution. It is industry's turn now to dream. Storage batteries at present are heavy and bulky; added to their slow recharging rate are their gaseous releases and relatively low total power. This is not the case of the plastic battery, which will undoubtedly be the "battery of the 90's." It has four advantages: Simplification, easy installation, speedy recharging and high total power--four assets that suffice to explain the interest it arouse among industrialists, even though, as of today, this battery is still in its experimental organic cellular stage. Its voltage per cell is around 3 V; thus, only four cells will be needed tomorrow to replace the six that presently comprise a [12-volt] battery. Simplification plus ease of installation, since the weight and bulk are reduced. Totally leakproof, it will not release any gases during recharging, which every battery does today. Recharging will require not more than 1 to 2 hours instead of the present 10 to 12 hours. One of its most important features will be its total power capacity, which is 4 to 5 times greater than the lead storage battery: 800 watt hours per kilogram versus 200 watt hours per kilogram, and, for equal power-storage capacity, one-third the weight.

Designed by the CEAC [European Storage Battery Company], associated with the CEA [Atomic Studies Center], this experimental 20 ampere-hour cell has been developed as part of the research effort in the automobile sector to create a 3 liters/100 km vehicle. It contributes its share to the weight-reduction battle (yield-vs-consumption ratio). Consisting, as do all other storage battery cells, of two electrodes and an electrolyte, it uses doped polymers. The positive electrode consists of a very thin film of conducting polymer in lieu of and replacing the lead dioxide of conventional batteries. A slender ribbon made of an entirely original alloy replaces the spongy lead

for the negative electrode. So much for the two poles of the battery. As for the electrolyte, it too is different, consisting of an organic compound rendered conductive by the addition of a salt. This eliminates the problems associated with sulfuric acid.

As things stand now, near the end of the developmental phase--a second experimental cell has already been built--certain problems have yet to be worked out; the components presently being used may not necessarily be the ones used in the industrialization phase, and the "all-plastic" battery will probably not have reached the industrialization phase much before the 1990's. Progress is being made in large strides, and meeting the stiff requirements of the specifications being stipulated by the automobile makers will render these batteries competitive.

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CSO: 3698/419

GERMAN RESEARCH, FUTURE POTENTIAL EVALUATED

Stuttgart BILD DER WISSENSCHAFT in German Apr 84 pp 78-91

[Text] Huge, coke-filled gas generators drive a mixture of nitrogen and hydrogen at a pressure of 200 atm. and 600 degrees centigrade through 20-meter high scrubbers, contact ovens and washers producing enough ammonia to make one million tons of nitrogenous fertilizer in the FRG alone each year.

Since the beginning of this century, this Haber-Bosch process has been used throughout the world to produce the nitrogenous fertilizer which agriculture needs in order to survive. Our domestic chemical industry turned out nitrogenous fertilizer in 1982 worth DM 1.75 billion.

But this might well be different in the days to come. In place of the large-scale industrial plants, billions of tiny microbe factories may be producing nitrate which they need to survive in the roots of cultivated plants from the atmospheric nitrogen which these plants do not need.

This is a view of the future as seen through the eyes of genetic engineers. An immensely lucrative business would then be based on the sale of cultivated plants or soil bacteria which have been technologically manipulated.

Basic researcher Prof Peter Hans Hofschneider, who has worked with viruses and bacteriophagous organisms for many years, takes a somewhat different approach to biotechnology. "The phagic system with which many molecular biologists are still working today has created the preconditions which enable us to study viruses which are pathogenic both for animals and human beings," he says.

"For example, there was no way to investigate the hepatitis-B virus in the absence of genetic engineering methods. Even today, we are still unable to reproduce this virus in tissue cultures. It was only the cloning of its information which made it possible to study the pathogenic mechanisms. That is how I found my way to biotechnology."

Both those concerned with basic research and with industrial application are in hot pursuit of the new methodology. With its help, the researchers can get at scientific problems which heretofore resisted all experimentation. And as for industry, it is putting biotechnology to use because it holds the promise of new production techniques and new products at less cost.

The methodology is so well established in the FRG by this time that there is hardly a single university whose molecular biology laboratory is not engaged in biotechnology.

"You can walk through our entire six-story institute," says Peter Starlinger, a professor at the genetics institute of the University of Cologne, "and you will not find a single project in which this methodology is not being applied at least part of the time." Starlinger himself is working in a field which really is on the move in every way: he has been active in the "transposable elements" or more popularly "jumping genes" field for a number of years.

It was in the sixties that Starlinger, along with his Cologne colleague Prof Heinz Saedler and a team of British researchers, was able to show that DNA fragments of bacteria have a tendency to jump back and forth within the genetic pool and to cause mutations in it. Last fall, the Nobel Prize committee honored 83 year-old geneticist Barbara McClintock for this discovery. She discovered and closely investigated the jumping gene theory in the corn plant many years earlier.

"As biotechnology continued to improve, there was a great temptation for us to get closer to Barbara McClintock's jumping corn genes," Starlinger says. And in fact, his research team did succeed in isolating these jumping corn genes and in cloning them.

The researchers' wish is to discover the exact biological functions of the material they now have in hand. "Perhaps," Starlinger says, "we will one day be able to integrate a foreign gene with an attached jumping component in a plant chromosome."

There is a research bottleneck in plant genetics because of the limited number of available "gene taxis." The truth is there is only one single vector—the "ti" plasmid of the agrobacteria—with the help of which the genetic engineers can introduce foreign genes into plant matter. This particular plasmid may have almost unlimited possibilities when it comes to dicotyledon plants but is of no use whatever in the case of all the grains which belong to the monocotyledon family.

If efforts to find a gene taxi for commercially worthwhile types of grain were successful, a number of problems connected with plant genetic engineering would be solved.

At another institute in Cologne, the Max Planck Institute for Breeding Research, scientists are working on similar problems. Jozef Schell, one of the institute's three directors, is one of the leading authorities in the ti-plasmid field. Now his research team is looking for alternatives to ti-plasmids—although it was this very DNA chain which contributed very substantially to the reputation of this research group.

Prof Heinz Saedler, head of the molecular plant genetics department, characterizes the Cologne Max Planck Institute's research activities by saying that they cover just about everything "from the DNA level all the way to farming as such." This wide range of activities makes the Cologne institute quite unique in the FRG.

Saedler does not wish to sing his own praises but one can tell that he is proud of the institute's high level of cooperation and its scientific standing. "We have a lot of American colleagues coming over to spend a research semester with us," he notes. "And we continuously have Japanese government delegations visiting us and looking our institute over because they would like to establish one just like it."

In addition to the separate research work conducted by the four individual departments, the institute's scientists have also agreed on a joint project they wish to undertake. "It is our goal to take an interesting gene and place it in an interesting cultivated plant," Saedler explains.

All types of grains would be commercially interesting; but this is also the field in which the most formidable obstacles exist. For this reason, the Max Planck Institute researchers settled on the potato—which is sufficiently attractive from a commercial point of view; its gene pool is easily accessible for the ti-plasmid and the cellular structure of this plant is well-known.

There is no dearth of suggestions regarding new genes which might be added to the potato gene pool. The farmers would be more than pleased, if the tubers were less susceptible to diseases such as potato rot or phytophtera. This would make it possible to cut down on the use of germicides—a reduction in the use of chemicals in agriculture being a stated aim of the Cologne researchers.

It would also be desirable to raise the protein content of potatoes—and either that or an improvement in protein composition is another long-range goal of the research team.

Dr Lothar Willmitzer, a member of Schell's department, is presently working on this aspect. "There are three major types of proteins which occur in potatoes," he says. "Together, they make up 70-80 percent of the total potato proteins. These proteins are coded by three genes and we think we have now isolated those genes."

No doubt there are quite a few ifs and buts included in Willmitzer's research project; but there are plenty of ideas and skillful hands to move the project along. The potato project is a case in point of genetic engineering methods taking over where classic breeding methods are of no avail.

Since the potato does not have a double set of chromosomes—as human beings do—but a quadruple set, classic hybridization experiments result in an astronomic number of genetic variations. A breeder would have to examine millions of individual plants until he hits upon the desired one.

"In those cases where it would take a classic breeder several years," Willmitzer says, "we genetic engineers can obtain results in just two potato generations—if it works out right."

Boasting some 50 scientists at the institute and a number of others at the university, Cologne is the "green" genetic engineering center of the FRG. But the Institute for Genetics also houses world-renowned immunological and virological research teams in addition to Prof Starlinger's green research group. Cologne is also the home of "red" genetic engineering.

But the lay of the land of this red biotechnology is a great deal more diffuse. This branch of genetic engineering is concerned with targeted manipulation of animal gene pools. It is called "red" because many of the activities in this field focus on human or animal blood.

It is still the group of the immune active interferons which attracts the unconditional interest of the many of the "red" genetic engineers—not only in the industrial laboratories.

Initially, the researchers of the Society for Biotechnological Research (GBF) in Braunschweig, for example, followed the lead of many of their colleagues—which was to isolate the beta-interferon gene occuring in humans and to insert it into the human intestinal bacterium E. coli, to produce the interferon there and finally to clean the product of cell fragments.

The Braunschweig researchers did succeed in achieving the expression of the beta-interferon in the E. coli but then the problems began to mount. At this time, the process is not yet suited for industrial application.

A renewed attempt led to success. Instead of E. coli, GBF researchers headed by Dr. Hansjoerg Hauser built mouse cells which had been modified with the help of genetic engineering methods. Into these mouse cells, a human beta-interferon gene was inserted. Using a process developed by the GBF researchers, mouse cells can be grown on plastic-coated microcarriers.

In the process, these mouse cells continuously produce human beta-interferon. A fluid courses around the cells on the carriers, absorbing the interferon. Subsequently, the beta-interferon can be isolated in a number of separation processes.

The process already works on the 25-liter scale—which is something the GBF researchers are very proud of. Negotiations are presently under way with Bioferon Co which may take the process over from GBF and turn it to commercial use. Bioferon, 50 percent of which is owned by Dr Rentschler pharmaceuticals of Laupheim and the remaining 50 percent by Biogen Co, brought out a beta-interferon product obtained from connective tissue under the trade name of Fiblaferon 5 in 1983 for use against herpes zoster. This product was the result of a cooperative effort by New York University and the Max Planck Institute for Biochemistry at Martinsried.

GBF geneticist Dr John Collins and Erlangen virologist Prof Bernhard Fleckenstein are jointly doing research on the cytomegalo virus (CMV). Almost 70 percent of all adults have contracted a CMV infection at one time or another, which normally is no worse than a common cold. But CMV poses a danger when it infects an embryo under which circumstances it may result in serious brain damage. "It is believed that some 50 percent of all backward children became so as a result of a CMV infection," Collins says.

He and Fleckenstein have now succeeded in cloning the CMV genome and they are presently trying to work out a diagnostic test. Their aim is to isolate the CMV surface antigens and/or their genes which trigger the body's own immune reaction.

If these antigens could be produced by means of genetic engineering methods—as can already be done in the case of the hepatitis B virus—a diagnostic test would be close at hand. "Within a year, this product could hit the market," Collins believes.

The long-range plans of the two geneticists are to develop a serum against CMV with the help of genetic engineering. In the case of CMV in particular this would be the only way to obtain a serum to provide immunity against the disease. Inactive viruses, like those used in standard flu vaccinations, cannot be used to protect against CMV—since inactive CMV's could cause tumors.

"I am a basic researcher pure and simple," says Prof Dieter Oesterheld of the Max Planck Institute for Biochemistry at Martinsried near Munich. He and his research team are really into basic biochemistry.

"Our interest lies in the relationship between the structure and function of certain macromolecules. Ever since the inception of genetic engineering, we have been confronted with something of a magic triangle consisting of the gene, the spatial structure of the gene product and its function. Thanks to the new method, it is now possible to conduct research on this triangle wherever we think best. As soon as we have one point of the triangle, we can get at the other two," Oesterheld says.

This is the strength of genetic engineering: that it enables researchers to tackle a problem from different angles. Once the molecular geneticists have discovered an interesting bit of DNA, they are in a position to analyze it and to predict what the structure of the gene product (or specific protein) will be. Conversely—if the peptide chemists are familiar with the amino acid sequence of a given protein, the molecular geneticists can draw a structural diagram of the appropriate gene for them.

Another thing has been added to this during the past 5 years: the molecular geneticists need not stop with the structural diagram. With the help of "gene machines," they are in a position to do a practical analysis of their diagrams by synthesizing the gene from its individual components and examining their functions. In most instances, the genes are not produced all in one piece—which is why the scientists prefer to speak of "oligonucleotide synthesizers" rather than "gene machines."

At first, American laboratory equipment manufacturers sold such machines to our genetic engineers. But now there are some German alternatives available to take the place of the American units which cost about DM 150,000 each. A synthesizer manufactured by Biosyntech Co has been updated and will be on the market in about a year in a computer-controlled, fully automatic version.

Compared with the high-tech equipment from the United States, Great Britain or the FRG, gene synthesis in the Braunschweig manner seems a bit archaic. GBF geneticist Dr Helmut Bloecker recalls how their "filtering method" got its start. "We always use teabags when we make tea at the institute," he says, "and that is how we chanced upon it."

Bloecker and his GBF co-worker Dr Ronald Frank, using lamellas, dip these somewhat like teabags into four laboratory receptacles containing the four basic DNA components of adenine, thymine, guanine and cytosine. The sequence of the bases determines the sequence of the immersion baths in the beakers. "Since we do everything by hand," Bloecker says, "we have no need for a lot of apparatus and that makes us faster than any machine available worldwide."

The setup on the laboratory table of the two GBF genetic engineers almost looks like a do-it-yourself genetic engineering kit. Nonetheless, they are serious contenders as a group of British genetic engineers at Leicester University had occasion to discover not too long ago. The Leicester team had set a world record by constructing the longest synthetic gene consisting of 514 base pairs. Leicester is one of the centers of genetic engineering in the British Isles: five universities are collaborating with ICI, the giant chemical conglomerate, spending millions on genetic engineering transfer.

In January 1984, the scientific-sportsmanlike ambition of the Braunschweig group broke the British record. Bloecker, Frank and their co-workers succeeded in synthesizing and cloning a beta-interferon gene with 517 base pairs—the longest synthetic gene in the world until now.

The point of course was not to fill one more page in the Guiness Book of Records. "It is our goal to make the synthetic gene more efficient than the human gene in the production of beta-interferon," Bloecker says. It is also conceivable that different forms of the gene might increase the length of retention of beta-interferon in the bloodstream or adapt its acceptance and distribution rate in the blood to specific needs by genetic means.

This is one of the fields which makes the genetic engineers' eyes light up. For some time, the interferons were looked upon as immunological jacks-of-all-trades; but now they must prove that they really are a force to reckon with in fighting viral diseases and tumors in clinical tests. Particularly in the case of tumors, it remains to be seen just how potent the interferons really are.

The new magic formula is "enzyme engineering"—which is another way of saying that enzymes are tailored to specific needs.

In their heads, the enzyme engineers have a clear idea how it should work. Enzymes are proteins and their properties are determined by their structure. The structure of proteins, in turn, is determined by the DNA base sequence. Since molecular biologists are not only in a position to replicate natural genes today but can also recombine them piece by piece, it should also be possible to synthesize slightly or heavily modified gene products—such as enzyme proteins for instance—through a gradual exchange of individual bases or even entire base packages.

To be sure, many of these modified enzyme models—just like non-directed mutations—will not be capable of doing their intended job. But some of them are likely to show different and better properties than the natural enzyme itself. This prospect is tempting enough to make many international industrial research organizations and basic research laboratories draw up plans for such projects.

This gives an indication of how close the connection between basic and applied research can be in the field of genetic engineering. Basic researcher Dieter Oesterheld, thinking of his magic gene-structure-function triangle, has the same dream of a protein modified with the aid of genetic engineering as his colleagues in industry who would like to come up with a technical enzyme for the manufacture of foodstuffs for example.

Basic research with a decidedly medical slant is being done by Dr Peter Mueller at the huge double-star-shaped Max Planck Institute for Biochemistry in Martinsried. "Traditional protein chemistry is powerless with regard to a great many hereditary as well as acquired diseases," Mueller says. "This is where genetic engineering methods have something to offer in the way of new diagnostic and therapeutic techniques."

The questions raised by Mueller are quite basic to start with: How does gene regulation work ? This refers to the strictly regulated procedure inside a cell that determines which DNA segment is activated or blocked at any given time.

"We soon realized that many hereditary bone diseases of human beings are caused by defective regulation of the genetic information contained in the bone-building cells," Mueller says.

This led Mueller and his group to clone the genetic information from both healthy and defective cells. They are looking for structural differences in the DNA strands because these differences should by rights be responsible for the defect--such as insufficient bone-building activity.

Prof Heinz Schaller, head of the microbiology department at Heidelberg University, is doing research quite similar to Mueller's. "Genetic engineering methods have enabled us to analyze complicated gene regulation systems," he told us. "This helps us at long last to establish a meaningful connection to basic medical research activities."

His present research deals with pathogenic microorganisms such as the hoof-and-mouth disease virus, the hepatitis B virus or so-called mycoplasms--which are cell wall-less bacteria which can cause diseases of the respiratory and genito-urinary tracts of humans and animals. In this area of medical virology, Schaller is also working with clinics both in Heidelberg and its vicinity out of a conviction that molecular biologists must assist the medical profession. "There are not too many medical teams in this country working in this field," he says.

Prof Albrecht Klein, a former colleague of Schaller's, who has since moved into molecular genetics at Marburg is working on an entirely different problem: the function of genetic information of methane-producing bacteria.

These bacteria are a crucial component in the mix of different types of bacteria contained in the septic towers of sewage treatment plants. These analyses, too, take as their point of origin the isolation of fragments of the DNA strand and its cloning. In the long run, this might lead to the development of bacteria which might make the decomposition process of industrial wastes more efficient.

It is not only at the Max Planck institutes, universities and large-scale research organizations that genetic engineering teams are at work; industrial laboratories, too, have grown over the past several years. Almost all the large chemical companies in the FRG and even small manufacturers of pharmaceuticals and dwarf-sized, specialized genetic engineering firms are taking up the international challenge.

With the aid of an advanced project for the production of human insulin the Hoechst Co. is aiming to meet the international competition in this highly lucrative market in the near future. For a year now, the American Eli Lilly Co has had a biotechnologically produced brand of human insulin on the market and the Danish Novo Industries A. S. conglomerate has charged the Biogen Co with the production of human insulin. Even if human insulin is not being sold for less than conventional animal insulin—after all, why should Eli Lilly undersell its own product—human insulin produced by genetic engineering techniques as well as semi-synthetically manufactured human insulin appears to be superior from an immunological standpoint to animal insulin.

In addition to the human insulin project, the 15-member Hoechst group of genetic engineers is working on vaccines and blood coagulants in the "red" genetic engineering field and one particular group is also beginning to do work in the "green" genetic engineering sector.

At Behringwerke, a fully-owned Hoechst subsidiary located in Marburg, there is a separate five-man group of genetic engineers that is also engaged in work on blood coagulants. They are experimenting with various coagulant factors in a number of production systems. Their experiments are with E. coli bacteria, yeasts and mammal cells with the aim of putting these to work as "microfactories" for the production of coagulants.

Coagulants such as factor A—which is needed for the treatment of hemophilia A—can only be obtained from human blood at this time. This is not only expensive but also full of risk, since the blood of millions of donors may pose the grave threat of a hepatitis B infection or of AIDS to the recipient. Costly blood tests must therefore be performed in order to determine the usability of the donated blood.

Frequent intravenous application also makes it impossible to use chemically similar blood factors of other mammals (such as insulin obtained from pigs), since this might to an allergic reaction on the part of the recipient.

The exact opposite of coagulants is also of great interest—a natural anticoagulant capable of dissolving blood clots in the lungs and the circulatory system up to and including heart attacks without side effects and risks. That is one of the palpable dreams of industrial researchers.

All over the world in fact industrial laboratories are looking for ways to manufacture such tissue plasminogen activators (or TPA's) by means of genetic engineering techniques. This factor which occurs naturally in the blood transforms the inactive plasminogen into the active enzyme, plasmin. This enzyme transforms the coagulant fibrinogen into transportable fibrin. In this manner, blood clots can be dissolved with the help of TPA.

Experts believe that a genetically engineered TPA product would have a market value of DM 1.3 billion annually. No wonder then that the giant Japanese pharmaceuticals firm of Sankyo is just as interested in applying the expertise of Britain's Celltech genetic engineers as the American chemicals giant Monsanto is in applying Biogen's know-how in their quest for TPA.

The FRG firm of Gruenenthal has already come up with a genetically engineered alternative to TPA—it is the thrombolytic enzyme urokinase. But Gruenenthal obtained the genetic engineering know-how for this product from California's Genentech Co.

But Prof Leopold Flohé, the head of Gruenenthal's research and development department, speaks of a milestone in his firm's research operations. "In the long run, the contact to California became a bit cumbersome," he says. "That is why we now work together with Prof Gunter Gassen of the Darmstadt school of technology."

In the long run, collaborating with the Californians would also appear to exceed Gruenenthal's financial capabilities. While Gruenenthal has more of an interest in therapeutic products, their partner, Roehm Pharmaceuticals of Darmstadt, is concentrating on technical enzymes such as proteases which are used in the tanning of leather.

Technical enzymes also are the focus of attention of Boehringer Mannheim Ltd of Tutzing. A group of four scientists and eight technicians has been engaged in genetic engineering projects there for the past 6 years and things are continuing to move.

Boehringer Mannheim is one of the few firms which already has some genetic engineering products on the market. In the technical enzyme field the firm is marketing two test systems for measuring the raffinose or lactose and galactose content in foods.

One of the Boehringer enzymes—alpha-galactosidase—may be used for raffinose splitting in sugar production. The unwanted trisaccharide raffinose contained in molasses will prevent the crystallization of the desired disaccharide sucrose, if it appears in too concentrated a form. Through the addition of the genetically engineered enzyme sugar output can be raised appreciably. E. coli bacteria with made-to-order plasmids take over the production of the alpha-galactosidase enzyme.

Just now, the Tutzing team is also working on the development of a genetically engineered TPA and another project there is devoted to the production of a monoclonal antibody in bacteria.

"Genetic engineering opens up opportunities in areas of interest of ours such as precision chemistry, pharmacology, nutrition and plant protection," says Dr Hans-Juergen Quadbeck-Seeger, the head of BASF's main laboratory. Just recently, active substance research operations were inaugurated in a DM 92 million structure specifically built for that purpose by BASF at Ludwigshafen. The building contains modern genetic engineering laboratories as well as a biotechnology center. The goal of BASF's research is to develop microbial and enzymatic techniques for the production of certain intermediate organic substances which are superior to conventional synthesizing processes.

The 1983 biotechnology research budget of DM 200 million of the Bayer conglomerate at Leverkusen also contained a DM 35 million item for genetic engineering research. But it will still be a number of years before Bayer's Wuppertal-Elberfeld research facility will be coming up with genetic engineering products.

Bayer genetic engineers are concentrating their research on blood plasma composition but do not expect to obtain any tangible results in this field for another 5 to 10 years. Bayer is also engaged in research in the technical enzyme and microbial waste water disposal field. "In the long term," which is to say without setting a specific time frame, Bayer is also hoping to begin producing genetically engineered substances to help in the protection of plant life.

At Berlin's Schering AG, four scientists are presently engaged in genetic engineering research. For some years now, these researchers have been working on ways to manufacture genetically engineered amino acids.

"The syntheses work in the laboratory," Dr Monika Klutz, Schering's press spokesperson says. "We are now trying to come up with a production process based on this." Schering's Munich subsidiary Diamalt would market the amino acids to be used in the production of foodstuffs.

Berlin, too, does not do without American know-how. Schering has given a development contract to the Genex Co of Rockville, Maryland for work on an amino acid project and a heart/circulatory system medication. For this latter project, the Genex researchers are to implant the gene of a human blood plasma protein in microorganisms in order to have these organisms produce the desired medication. Monika Klutz refuses to go any further than that. "We have a specific agreement with Genex not to give out any additional information," she says.

Such cooperative ventures are by no means inexpensive. Some firms, in fact, frequently turned down the U.S. cooperation offers. Dr Klaus Beaucamp, head of the genetic engineering research team at Boehringer Mannheim in Tutzing, puts it this way: "The cooperative ventures offered to us frequently exceed our own financial limits."

Boehringer Ingelheim has been working on interferons for a number of years and has been collaborating with one of the most active American genetic engineering firms. Boehringer is currently running test phase I (tests with healthy individuals) in several European countries with genetically engineered gamma-interferon produced by the California firm of Genentech.

For the future, Boehringer Ingelheim is looking to the antiviral interferons and is also planning to work on leukocyte interferon (alpha). But on this project, they will have to do without Genentech cooperation, since the Californians are already collaborating with Swiss competitor Hoffmann-LaRoche on alpha-interferon.

Looking at the work being done by the industrial laboratories, one thing becomes very clear. Despite the variety of projects being undertaken, the German firms are either unwilling or unable to do without the know-how of the American genetic engineers.

Looking at the state of genetic engineering for industrial purposes in the FRG, it is therefore safe to say that the American laboratories are clearly and incontestably ahead in development.

The next wave of genetic engineering products to hit the market will be based almost exclusively on American patents. But Prof Hansgeorg Gareis of Hoechst AG, for one, is still optimistic. "Just now, we are in the process of making important strides to help us whittle down the relatively small lead the others have," he says.

Klaus Beaucamp, head of Boehringer Mannheim's biochemicals research staff, does not think the FRG has missed the boat in genetically engineered products either. "German industrial firms," he says, "did not start on this at a significantly later date than their American competitors."

Nonetheless, the Americans—Eli Lilly, for example—had been pumping billions into this type of research for the past several years. FRG investments are a great deal smaller than that. But by now the FRG chemical industry has entered the race and is expanding the genetic engineering teams in its own laboratories.

The fact is that gene research in the FRG is marked by increased activity and greater interest both on the part of industry and of government research grants.

The reason why our starting position in the race for genetic engineering markets was poor certainly is not that our researchers are "mediocre" or that there are "too few" of them. Many molecular biologists who got their education in this country left for the United States in the late seventies and early eighties only to come up with U.S. genetic engineering patents in working for some of the leading genetic engineering firms in the United States.

Genetic researchers in the FRG do not agree on what the international standing of German basic research in genetic engineering really is. Hubert Koester of Biosyntech is skeptical. "Even in basic research," he says, "the Japanese and the Americans are slightly ahead and in microbiology—in fermentation technology, for example—Japan has traditionally enjoyed a substantial lead because of the type of food that is produced there.

"Above all, it is the breadth of the work being done in biotechnology in the United States and in Japan; in the FRG, on the other hand, we have a handful of outstanding centers. Hamburg University, for instance, does not even offer a molecular biology curriculum."

Dr. John Collins sees things in an altogether different light. "In basic genetic engineering research Japan is not particularly impressive," he says. "In that field, the German scientists are better and above all, more imaginative than their Japanese counterparts. But if you are talking about industrial application, then one would have to admit that research findings are not well applied in this country."

Nonetheless, Collins does not believe in scientific hit lists. "I fly to Japan once a year and several times to the United States or Sweden or France," he says. "Science has become increasingly internationalized. National arguments do not really count as much as they used to." Chances are that a Briton working in Braunschweig finds it easier to come up with a somewhat more positive response to the question of the FRG international standing.

Though some scientists say that the level of training of West German molecular geneticists is not up to par, Cologne researcher Peter Starlinger thinks otherwise. "Our current crop of students is very capable and committed," he says. "They are conducting much more difficult experiments than we did 30 years ago. Many of them have joined the staff of U.S. laboratories and are highly esteemed there."

"The educational level at some of our universities is quite competitive internationally," says his Hamburg colleague Hubert Koester, "but there is a very definite quantitative training deficit."

Peter Hans Hofschneider of Munich feels that hesitation on the part of the chemical industry is one reason for the German lag in genetic engineering projects. "These firms have done marvelous things in the chemistry field for decades," he says. "Under the circumstances, it is not surprising for these firms' managements to be cautious about developing new techniques particularly if these are of only limited interest to chemistry."

But the perhaps crucial reason for the comparatively faster pace of progress in the United States, according to Hofschneider, is the difference in organization and planning in the United States and the FRG. "There simply is a greater challenge in the United States," he says. "One can win a great deal—but one can also lose. No wonder that scientists and managers go at things

with more drive most of the time in the United States. In that sense, it is not at all bad for German teams to be exposed to this particular style of operation."

Heinz Schaller thinks along somewhat the same lines. "In our situation," he says, "a good many initiatives are slowed down, if not stopped dead in their tracks at the very outset because of a welter of administrative regulations." But Schaller does not feel the situation is hopeless. "In principle, we can keep pace with the United States in the gene market," he says. "To be sure, there are more heads and hands there, working on projects—and they are doing so with far greater nonchalance."

There are those who say that German researchers are possessed by a need for job security; but Starlinger does not agree at all. "Every one of our young co-workers who went into research given the present state of affairs made it plain enough that he was willing to take risks—or am I wrong ?"

The History of Genetic Engineering

1869—Friedrich Miescher discovers nucleic acid in the cell nucleus of white blood corpuscles in pus.

1944—O. Avery proved that deoxyribonucleic acid (DNA)carries genetic information.

1953—James Watson, Francis Crick and Maurice Wilkins discovered the double helix structure of DNA.

1967/68—A number of research teams discovered major instruments of gene surgery: the restriction enzymes (scalpels) and ligases (linkers).

1973—American Paul Berg succeeds in transferring a bacterial gene to a virus. Herbert Boyer and Stanley Cohen work out basic recombinant technology (Cohen-Boyer patent).

1975—At a conference in Asilomar, CA, scientists adopt a limited moratorium on certain types of DNA experiments.

1976—The U.S. National Institutes of Health put out regulations for dealing with gene technology. Genentech, the first genetic engineering firm, is established.

1977—Howard Goodman implants a gene (rat insulin) in E. coli bacteria for for the first time ever.

1978/79—The gene for human insulin and the growth hormone are transferred to E. coli bacteria.

1980—The U.S. Supreme Court rules that new forms of life may be patented. relaxes the gene regulations to a large extent. Biotechnology stock is traded on the stock market for the first time. Biogen and Genentech both succeed in synthesizing immune proteins (interferons) in E. coli bacteria.

1981—Howard Goodman signs a 10-year, $50 million research contract with the German firm Hoechst AG. L. Hood and others build the first gene synthesizer. Hubert Koester, a professor at Hamburg University, establishes the first German genetic engineering firm, Biosyntech.

1982—The American pharmaceutical firm of Eli Lilly puts the first genetically engineered medication (human insulin) on the market. Gene transfers between two different mammals are now possible: an American research team headed by Ralph Brinster transplants a rat growth hormone gene in mouse embryos and creates a giant mouse. Prof Christian Birr establishes the second genetic engineering firm in the FRG in Heidelberg and calls it Organogen.

1983—The firms of Gen-Bio-Tec and Progen are established in Heidelberg. Establishment of four genetic research centers at Munich, Heidelberg, Cologne and Berlin to deal with joint research projects funded by the federal government, the Laender, the universities, the Max Planck Society and a number of industrial firms.

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GERMAN COMMERCIAL INITIATIVES INCLUDING BIOSYNTECH, BIOFERON

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[Article by Rolf Andreas Zell and Thorwald Ewe: "Know-How Leads to Profits"]

> [Text] Molecular biologists are establishing business firms, becoming consultants and stockholders. The FRG is the latest country where genetic researchers are trying to come up with marketable products. But those who do try still find that there are a great many obstacles.

The experts do not agree on what standing FRG genetic research has worldwide; but they do agree on the international standing of West German bureaucracy. One man who has had occasion to convince himself of it over the past several years is Prof Hubert Koester of the organic chemistry and biochemistry institute of Hamburg University. "In any international competition, German bureaucracy would be right up there at the top," Koester says.

Koester, a peptide expert, has been working in the genetic engineering field for a number of years. He was convinced that this new branch of biology would come to play a major role.

He was serious about the concept of technology transfer and therefore collected DM 1 million from among his relatives and founded Biosyntech in Hamburg, the first genetic engineering firm in the FRG, in 1981.

"Something had to happen, if we did not wish to lose out to the world leaders in genetic engineering as we had earlier in the field of microelectronics," Koester says. But he soon came to realize that a research-intensive genetic engineering firm could not be funded with just DM 1 million and that the firm would not be able to establish itself on the market without management know-how.

He therefore went looking for more capital and a managing director. In early 1983, he assigned that post to Wolfgang Steude who until that time had been in charge of the tax department of a pharmaceutical company. Between them, they laid plans on how to finance Biosyntech and that is when the Ping-Pong game with the bureaucracy started.

"We have submitted several proposals for funds to the Ministry for Science and Technology (BMFT) but none of them worked out," Steude says, "neither the genetic engineering subsidy program, nor the microelectronics target program, nor the program to assist technology-oriented firms in getting started."

In its encounters with the BMFT, Biosyntech looked to the Risk Finance Administration (WFG) for assistance. Biosyntech applied to the WFG for funds to finance a project to develop a genetically engineered vaccine. "By now," Koester says, "the project is passé from a scientific point of view because of the long time they took to work on the application."

"The BMFT turned down the application," Steude adds. "They said our capital cover was insufficient and the WFG to which we had also applied for the funds told us it would not assist our firm without BMFT funding."

The WFG is a private sector consortium made up of 29 West German credit institutions. Its main purpose is to provide funds to medium-sized firms considered to have innovative potential. By September 1983, the WFG had extended minority partnerships worth a total of DM 36 million to 36 business firms.

Koester and Steude turned out mountains of application forms, financial plans, project descriptions and timetables during the first year; but the bureaucracy remained adamant: no subsidies without capital and no capital without subsidies. Steude shows us a thick folder full of documents. "After months of red tape," he says, "we received a three-line note from the BMFT, saying they would not subsidize us and giving no reason for it."

And all this despite the fact that the minister himself has been saying that genetic engineering is one of the "key technologies" of the future and therefore needs to be subsidized more than most. Koester and Steude believe that the criteria being applied by the ministry are responsible for the fact that young, innovative, albeit risky undertakings do not get the kind of assistance they should be getting.

"Only the big firms get subsidies for their R and D programs," Steude complains. "There is no risk involved in handing DM 2 or 4 million for research and development to a firm like that. Their programs have been checked through so thoroughly that they always appear to hold "technological promise" and since the big companies are backed up by powerful financiers, the responsible BMFT official may be said to be acting within his guidelines."

"We only subsidize those industry projects which are either especially risky or particularly interesting from a scientific-technological point of view," says Dr Hans Michael Biehl, the BMFT official responsible for genetic engineering. "The criticism directed against us by the newly established

genetic engineering firms is justified in the sense that funds from the "biotechnology" program can only be made available to firms which have a solid private sector base."

"As far as the courage to take risks goes," Biehl says, "we are all for it. But we must be looking at ideas that are worth subsidizing and that was not really the case with respect to the Biosyntech application.

"If you take a look at big industry—unfortunately, there was no great willingness to take risks for some time, nor did we detect any readiness to go into new technologies at all speedily. The BMFT, after all, has been making grants in the biotechnology field for the past 13 years and in the genetic engineering field for the past six. Industry did not start to pay any attention until 2 years ago."

At any rate, Biehl believes that small, innovative firms definitely have a chance on the market. "There is a great deal of uncertainty about the direction in which research is headed," he says. "This is where the strength of the small firms lies which can react more flexibly than big industry because of the research contracts they get. The situation in the FRG is by no means hopeless. Some people are thinking about establishing new firms and as for us, we are prepared to support and subsidize such projects without, however, becoming partners ourselves."

In the meantime, Koester's Biosyntech has turned into a limited private partnership company, backed by a powerful group of shareholders. "Following a substantial increase in our capital stock," Steude says optimistically, "we will have the necessary peace and quiet to do our R and D work and our capital partners are willing to put in extra money even after that." In fact, Steude believes that the present 14-man firm, located on Stresemannstrasse in Altona, will be in the black within 3 years.

A first group of products has already reached the market: they are components for structuring DNA fragments and, ultimately, genes. In the future, Biosyntech also expects to be competitive in the presently U.S.-dominated "gene machine" sector. The firm is also working on genetic engineering products but is unwilling to go into particulars.

Heidelberg area researchers appear to be especially busy at this time. In 1982 and 1983, three new genetic engineering firms have sprung up. One Heidelberg scientist took heart and left his safe job at the Max Planck Institute for Medical Research in Heidelberg to start his own company.

It was Prof Christian Birr, who founded the Organogen Ltd in November 1982. Not wishing to work without any safety net at all, Birr, under an agreement with the institute, may return to his old job within 5 years, if Organogen does not succeed. With DM 50,000 of his own savings, several patents and a great deal of tenacity he, too, went looking for capital last year.

Birr's experiences sound familiar. "The application process for business start-up loans is too cumbersome," he says. "It took 9 months for the initial payments of less than DM 300,000 to be made into an account. The BMFT should provide more of an incentive to individuals willing to start their own business in order to show them which kind of subsidy program they can expect to be a part of."

In the end, Birr did find the kind of people he was looking for in the state of Baden-Wurttemberg. "That Land's assistance programs are simpler, faster and more comprehensive. Within less than 3 months, I received DM 1.5 million from the business assistance program for followup financing purposes."

The Organogen laboratory is presently located in the former slaughterhouse grounds which are being leased at low cost by the city of Heidelberg. The firm now is in the process of compiling a product catalog. Birr's long-range goal is to manufacture "medicines which are not typical chemical drugs but natural regulatory molecules of the immune system."

To do this, Birr and his staff of 11 will initially be relying on conventional biochemical synthesis to turn out their products. Later, they expect to turn to genetic engineering techniques.

The poor outlook for an individual to develop his potential in institutional research and the poor job opportunities for molecular biologists generally caused trained chemist Reinhold Sommer to start the firm of Gen-Bio-Tec in Heidelberg after finishing his studies with Profs Heinz Schaller and Werner Franke at Heidelberg University.

He, too, spent most of 1983 talking to representatives of the WFG, the Wurttenberg-Baden guaranty bank and to private financiers.

After some initial hesitation, the WFG will provide Gen-Bio-Tec with the DM 300,000 the firm needs in order to obtain a non-refundable project subsidy of DM 900,000 from the BMFT. The provisions of one of the new assistance programs are such that the BMFT will not subsidize a project unless a 25 percent capital risk contribution has been made beforehand. Sommer was surprised to find that Wurttemberg-Baden's middle class assistance administration now has an interest in Gen-Bio-Tec's production plans, too—that body providing an additional DM 300,000 in capital to the firm.

Sommer believes he can find a spot on the market in DNA sequence analysis—analyzing which DNA building blocks follow each other—and in gene synthesis. This January, Sommer obtained a license from the Braunschweig Society for Biotechnological Research (GBF) to use GBF's filtering process to synthesize DNA.

Sommer's seven-man team is already hard at work on the largest synthetic gene under contract to a big conglomerate. Sommer's researchers are trying to break the "world record" set by GBF biochemists Helmut Bloecker and Ronald Frank in December 1983 when they synthesized an interferon gene consisting of 517 base pairs.

Sommer is also trying to develop two drugs for human use by means of genetic engineering techniques and put them on the market. One of the products is to be produced by a Gen-Bio-Tec partner and the other by Gen-Bio-Tec itself. But Sommer will not say exactly what it is that Gen-Bio-Tec is in the process of developing.

In the trade, the four Heidelberg scientists who jointly with Duesseldorf management consulting firm BERA formed Progen Biotechnik Ltd in November 1983 with capital funds of DM 20,000 each are said to be "moonlighting." The reason they are being labelled as such is that the four will continue in their present jobs.

Prof Ekkehard Bautz holds a chair for molecular genetics at Heidelberg University; Prof Peter Gruss heads a research team at the Institute for Microbiology as well as at the molecular biology center of Heidelberg University; Prof Guenter Haemmerling is deputy director of the Institute for Immunology and Genetics at the German Cancer Research Center (DKFZ) in Heidelberg and Prof Werner Franke is managing director of the Institute for Cellular and Tumor Biology of the DKFZ.

At this time, Progen is offering silent partnerships on the open market. In view of the initially planned losses to be incurred by Progen, high-earning investors have an opportunity to reduce their own tax burden. At the same time, their participation offers them the option of buying Progen shares on the stock market in order to share in the possible profits the firm may realize.

Progen's general manager Bodo Spiekermann, the DKFZ's former business manager, spoke to us about the firm's financial policy. "We are aiming at four target groups: private investors, business firms, risk capital companies and banks."

By 1988, Progen would like to have these investors make DM 13 million available. At this time, private investment in the firm amounts to DM 1.1 million and the firm is negotiating with the remaining three groups for about DM 7 million more.

It does not seem to be easy to attract private investors to the project. "We have found that it is more difficult to get people to invest in an innovative undertaking which holds great promise for the future like Progen than to sell homebuilders' models," says Ekkehard Bautz, one of the partners in the firm.

Progen has its sights set on two targets: the development of diagnostic testing procedures using monoclonal antibodies. In view of their experience, the Progen scientists believe they have a chance to enter the market above all with a product in the tumor-diagnostic sector. Progen's other goal is to develop genetically engineered vaccines, genetic tests, bacteriostatics and made-to-order enzymes.

Progen's managers expect the firm to make a profit within 6 years at most with the help of increased research contracts and earnings from licensing agreements. For a number of projects they expect to obtain BMFT subsidies of DM 1.7 million annually. The ministry will get about 20 percent of the earnings from licensing arrangements at a later date.

All the firms have given some thought to staff participations. Organogen and Gen-Bio-Tec will definitely be offering some such arrangement but Biosyntech general manager Wolfgang Steude does not think it will work in his firm. "We would certainly like to motivate our staff more by offering them a share in the business. But our tax laws do not allow for such participation in personal partnerships as they would, for example, in the case of a stock company. In a personal partnership, participating staff would become partners and their income would no longer be deductible as operating expenses."

"For staff members—turned-partners, participation would make no sense at all," Koester adds, "because any losses the firm might incur would be deducted from their income. We are hoping for a speedy revision of the tax laws on this point."

Heinz Schaller, a professor at Heidelberg University, and Prof Peter Hans Hofschneider, the director of the Max Planck Institute in Martinsried, were particularly attracted from a scientific point of view by the plans outlined by the currently fifth-largest genetic engineering firm of Biogen which gathered a whole array of world-renowned scientists on its advisory board.

The two were asked to examine what practical applications could be derived from the basic research projects on which they were already working. The scientists would then be able to realize such application-oriented research projects with Biogen's help.

The scientists were initially given "Biogen shares" with no resale value which were a way of participating in the commercial successes and failures of the company.

To do just a little bit of "research like Rothschild" in an international setting without any financial or administrative restrictions—that is what has motivated Profs Schaller and Hofschneider to join in the work on two of Biogen's projects thus far.

Hofschneider and Schaller along with some Tuebingen colleagues succeeded in cloning a number of genome segments of the hoof-and-mouth disease virus. To be sure, the product obtained from these segments does not have the kind of optimal immunizing potential desired of a vaccine. While that particular vaccine project is being worked on at the Biogen laboratory in Geneva in its entirety, Hofschneider and Schaller are making use of the clones as part of their research into the genome structure of the hoof-and-mouth virus as well as other, smaller RNA viruses.

It was Prof Hofschneider, too, who started the cloning of the hepatitis-B virus. "Without the help of Biogen, this project could not have been undertaken," Hofschneider says in retrospect. Kenneth Murray, a British colleague of theirs in Edinburgh, carried on the joint work with Prof Schaller so successfully that Biogen now is in a position to produce a diagnostic test kit for hepatitis-B. In Japan, a "Hepatitis-B-Core-Antigen-Diagnostic-Test" has been in existence since May 1983. The Behringwerke Co purchased the antigen from Biogen and developed their own diagnostic test for hepatitis-B from it.

This does not mean, however, that Hofschneider and his team have completed their work on the hepatitis-B virus. They are presently looking into the hypothesis that the hepatitis-B virus may be partially responsible for causing primary liver carcinoma. "If that is the case," Hofschneider says, "the hepatitis-B virus would be responsible for more deaths than lung cancer caused by smoking." Schaller's team, too, is continuing to do work on the hepatitis-B virus. It is looking into the life cycle of the virus and its host and organ specificity.

Schaller and Hofschneider are convinced that conflicts of interest arising from their dual role as government-funded basic researchers and consultants for a genetic engineering firm can be avoided as long as clear guidelines are established for such sooperation.

"Basic research must be given absolute priority," Hofschneider says. "Application-oriented research will be done at the Max Planck institutes only if the personnel involved is paid by a third party. For another thing, applications for patents which arise from any such cooperative effort must not be permitted to delay publication of findings.

"Thirdly, the research institutes themselves must establish the proper guidelines for the protection of inventors based on the applicable laws. We already have the employee-inventor law and the subsidiary gainful employment rules for university professors in public service. These rules not only set down how much the scientist is entitled to but also what amount goes to the participating institution."

"The Biogen projects," says Prof Schaller, "have provided me and my Heidelberg colleagues with much scientific information and they have provided our institute—in contrast to government assistance—with additional funds which help us fill the gaps in the basic equipment needs of a university institute. This has enabled us to do efficient work both in research and in education over the past few years. Furthermore, such projects differ—both in their implementation and publication—from other research work being done at the institute which is being funded by the German Research Association (DFG) or the BMFT.

"All the Biogen projects are based on contracts with the university which stipulate that the university will share in any commercial profits resulting from the research work. In that sense, I have to be thankful that there is a firm which has been investing money in our basic research activities for years and that these activities may lead to commercial applications."

Hofschneider's Cologne colleagues Prof Heinz Saedler, the director of the Max Planck Institute for Breeding Research, and Prof Peter Starlinger of the Institute for Genetics at the University of Cologne are both wary of possible conflicts of interest.

"As far as I myself am concerned," Starlinger says, "I do not think I could keep my mind on basic research, if I also had to worry about running a business."

"Since we are operating on public funds," Saedler says, "we have an obligation of not only making our know-how available to a particular business firm but to the general public. We would rather not get into a squeeze caused by non-public funding. The pressure of having to work with public funding is big enough as it is. We want to be able to speak our mind and to continue as an open institution."

Biogen, at any rate, has certainly profited from enlisting the services of top-level scientists. Biogen's collaborative effort with British scientist Kenneth Murray of the University of Edinburgh resulted in a breakthrough in the search for a genefactured vaccine for hepatitis-B. At the Porton Down L 4 laboratory, leased from the British defense department, Murray first succeeded in cloning the hepatitis-B core antigen and then, last year, in cloning HBS antigen in yeast cells which is important for the production of the vaccine itself.

Following a number of successful animal tests with chimpanzees, a first series of clinical tests has now been started. By 1986, Biogen hopes to have a hepatitis-B vaccine on the market which will only cost \$10 to \$30 per person instead of the present \$100.

An outstanding event in West German genetic research was the May 1981 decision by Hoechst to invest $50 million over the next 10 years in Howard Goodman's genetic engineering institute in Boston. In summarizing the results so far, Prof Hansgeorg Gareis, a deputy board member of Hoechst AG, had this to say:

"2½ years ago we signed the contract with the people in Boston. By now, we have a team of 15 scientists here at Hoechst working on this project exclusively. We do not expect Boston to turn into a kind of patent factory. We have sent some of our staff over there to learn techniques they could not learn here—at least not in this kind of immediate and uncomplicated fashion. But there are also some new discoveries which are beginning to bear fruit."

No more than any of the other chemical giants Hoechst is prepared to talk about its product research operations. "Before we start talking about particulars," representatives of the firm are apt to say, "we must have a saleable product." This, for instance, is what BASF press spokesman Walter Geschwill told us.

In this regard, too, West German big industry is different from the American genetic engineering firms. Hardly a month goes by without Genentech, Cetus, Genex or Biogen putting out a press release to introduce a new project undertaken in association with industry or to announce some new breakthrough in research. The idea, after all, is to keep the shareholders, who invest their money in the firm's research operations, happy over an extended period of time.

"The risks involved in investing in a firm such as Biogen are great," the September 1983 Biogen report said in part, "since a positive cash flow is not to be anticipated for the next several years." This despite the fact that the first Biogen products are either already on the market or are about to be introduced in the near future.

Genentech—the giant in the industry with its staff of 500—made a profit of $902,000 for the first time between January and September 1983 while Eli Lilly, the American pharmaceuticals giant, which is producing human insulin under a licensing agreement with Genentech has taken over 30 percent of the human insulin market in the FRG. In all, four percent of all the insulin sold on the West German market today is genefactured.

According to a survey of the American periodical BIOTECHNOLOGY NEWS, gross sales of genetic engineering products on the world market amounted to $120 million in 1982. For 1985 the experts expect sales of more than $3.7 billion. The question is how much of this amount will be earned in dollars and how much in German Marks.

The German chemical conglomerates are not altogether inactive. Aside from starting their own research teams, BASF, Bayer, Hoechst and Schering are

participating in the operation of four FRG "genetic centers," a joint undertaking of the universities, the Max Planck institutes and a number of new institutions as yet to be established with financial support from the federal government, the Laender and industry.

In Berlin, for example, the city government and Schering AG reached a final agreement in September 1983 on the construction of a jointly funded institute for cell biology. Actual construction will start this spring on the grounds of the Max Planck Institute for Molecular Genetics in Berlin-Dahlem. The funding will be shared equally by the two partners, amounting to DM 80 million over the next 10 years. The annual budget required for the operation of the institute is expected to be DM 6 million to pay for a staff of 35.

A search for a director of the institute, who will also hold a teaching post at the Free University, has already begun. According to Schering board member Dr Klaus Pohle, some 50 scientists from Germany and abroad have applied for the job. A decision is expected for May of this year.

This February, several research teams headed by Prof Ernst-Ludwig Winnacker inaugurated the activities of Munich University's genetic engineering center in space rented from the Max Planck Institute at Munich-Martinsried. Additional working groups are to be formed as part of university institutes and Max Planck Institutes for Biochemistry and Psychiatry. DM 25 million are expected to be made available by the BMFT and another DM 4.8 million by Wacker Chemie and Hoechst AG.

By establishing a "central facility" to serve the university, the Munich group succeeded in overcoming one of the most difficult hurdles in the organization of a genetic center—namely the so-called capacity guidelines which require every increase in staff to be matched by an increase in the number of students at the university. It is unlikely that the other biological scientists at the universities would have agreed to an additional workload just to please the genetic engineering faculty. But the Munich genetic center, operating as a central facility, will not be subject to the capacity guidelines.

These bureaucratic hurdles faced by the Munich project make it clear why Hoechst originally decided to invest in Boston. "The university, the Max Planck Society, Hoechst AG, the ministry of culture and Minister President Franz-Josef Strauss all want the center," Prof Hofschneider explains. "But just the same it takes ages. The Max Planck Society, for example, can enter into negotiations with the university administration only via the ministry of culture. Even a letter takes 3 days under those circumstances."

Hansgeorg Gareis describes the American alternative as follows: "Boston, after all, is a private university. And if the president of the university says 'let's do it,' then it is done. In Munich, nothing moved for a full 9 months."

It has been agreed that the center will move to the site of the old Max Planck Institute in Munich's inner city following a transition period at Martinsried. Plans also are to create a biology laboratory in Munich in which the university's chemistry, biology and medicine departments will collaborate on genetic engineering research on an interdisciplinary basis.

Industry funding for the center is not to result in industry influence on research projects. For this reason, Wacker Chemie will pay DM 200,000 and Hoechst AG DM 1 million each year to a non-profit organization interested in microbiology research.

Ernst-Ludwig Winnacker, president of this organization, explains how the funds are to be disbursed. "We want to use this money to promote the type of investments which the BMFT or the Land cannot handle--such as hiring scientists outside the civil service contract limitations which will help us get some truly top people on the open job market."

Since November 1982, the BMFT has budgeted DM 15.4 million for another genetic center with funding to continue until December 1986. A year ago, the Max Planck Institute for Breeding Research in Cologne and the Institute for Genetics at the University of Cologne kicked off the Cologne genetic center with 13 research projects under the general heading of "molecular cell and gene technology."

In addition, the Land of North Rhine-Westphalia will put up the money to build a new laboratory building next to the existing Max Planck Institute. In this building, six independent research teams are to work on their particular genetic engineering projects. Bayer contributed new stables for animals and greenhouses. The Land also appears to be prepared to provide more space to the Institute for Genetics.

At Heidelberg, where the FRG's fourth genetic center is located, the "Center for Molecular Biology Heidelberg" (ZMBH) is already under construction. While the prefabricated sections are being put into place at the building site on Neuenheimer Feld, the two temporary project coordinators, Profs Heinz Schaller, and Ekkehard Bautz, are already planning what is to go inside the new buildings.

Within a year, some 20 different teams, using genetic engineering techniques, are expected to be doing research there in the fields of neurobiology, cell differentiation and the specific interaction among cells. Nine research teams are already at work there today.

As in Munich, the Heidelberg operation acts as a central facility of the university. To pay for the construction costs, the Land of Baden-Wurttemberg is contributing DM 30 million. Most of the money--DM 17.9 million, budgeted until 1985--comes from the BMFT. BASF will be contributing DM 1 million annually for the next 10 years. The 10-year agreement between BASF and the

and the university stipulates that BASF may assign up to two of its staff members to the center to join in the research projects being worked on there.

Within less than 2 years, there will be a need for at least 200 qualified molecular biologists in the FRG to help start up these centers. But many scientists doubt that a sufficiently large number of researchers can be found.

"Perhaps four centers are too much," says Prof Heinz Saedler. "But this concentration of effort is to the advantage of both young scientists and their training and of industry which will be recruiting its staff from among this cadre." Schaller, his colleague from Heidelberg, adopts a pragmatic view of the situation. "At this stage of the game, we not only need brains but brawn as well in order to obtain the critical mass. That is the only way of getting the best possible results."

The debate in the United States has already gone one step further. Two American molecular biologists—Stanley Cohen of Stanford University and Herbert Boyer, formerly of the University of California in San Francisco—have been in the forefront of an extremely controversial debate with regard to the protection of inventions in the genetic engineering field. In an article which appeared in the November 1973 issue of PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, the two men gave a description of gene splicing, the basis of almost all gene transfer technology.

Researchers are taking advantage of the travel potential of circles of DNA (plasmids) to transfer genes from one organism to another. This procedure of using a kind of Trojan Horse as a carrier of genetic material between different types of organisms is the basic concept underlying virtually all aspects of biotechnology.

No wonder then that Stanford University not only applied for a patent only a year later but was also granted the rights. This established the basic genetic engineering patent and up until 2 years ago, 73 firms were paying $10,000 annually to the patent division of the university for the use of this process.

But soon doubts began to be raised as to whether the patent was legal. For one thing, Cohen and Boyer had not been able to give a fully convincing explanation of how their gene taxi—pSC 101, the 101st clone of a Stanley Cohen plasmid—had come to be. In the patent application, at any rate, they had listed an entirely false derivation. They had also failed to provide the patent office with a sample of the plasmid itself—which is the customary procedure in the United States when applying for a patent in the microorganism field.

For another thing, a co-worker of the two patentees stated in the scientific journal NATURE that he had had a part in the discovery. This was reason enough for the U.S. Patent Office to take a very careful look at the Stanford affair.

In the FRG, too, the question of patenting genefactured products and genetic engineering processes is a controversial one. "When we start patenting processes," says Hamburg's Hubert Koester, "we leave the door wide open for the competition. These days, it is a better idea to keep one's mouth shut and to take advantage of one's lead in know-how."

"Perhaps the development of genetic engineering will be similar to that of microelectronics," Prof Hofschneider adds. "In that field, it is only time to the market that counts and the firms are not interested in patent protection at all."

"Global patents of this sort which try to exclude the rest of world are not going to work," Christian Birr says with reference to the Stanford patent. "They are phrased in such a general way that each special case can be interpreted as having a discovery value of its own."

Saedler even feels that the flood of patents in the plant field poses a serious threat. "If there is a deluge of U.S. patents to protect individual species, the German plant growers will go under."

But he does believe that genetically engineered plant species can indeed be patented and that a fiasco such as occurred in the case of the Cohen-Boyer patent need not repeat itself. "In the DNA field," Saedler says, "a patented species is immediately recognizable. There are kinds of genetic watermarks that can be recognized: specific leaping gene elements or receptors for restriction enzymes."

Dr Hans-Hermann Schoene, head of the pharmacological research/biochemistry department of Hoechst AG, feels the problem of patenting products is less thorny than that of patenting processes. "All the people I have talked to are not sure how well patent protection will work. Genetic engineering processes represent a kind of grey area which is wide open."

"To tell the truth," Hansgeorg Gareis, also of Hoechst AG, says, "I am not so worried about patents in this field. In genetic engineering, know-how is more important. But the outcry over industry's allegedly establishing monopolies on certain living organisms--that is nonsense in my view."

Almost all molecular biologists believe it is nonsense to draw up a gene safety law. As late as 1975, genetic researchers at the Asilomar Conference in California still thought that genetically manipulated microorganisms might pose very serious threats indeed.

At that time, world-renowned scientists called for a moratorium on certain genetic engineering experiments. The fear of epidemics caused by genetically manipulated microorganisms or microorganisms "gone wild" turned out to be biological non-catastrophes, however.

Nonetheless, the then debate resulted in proposals for legislation to regulate genetic engineering experiments—in the United States first and then, in 1976, in the FRG as well. The Central Commission for Biological Safety (ZKBS), set up by the West German government, watches over compliance with certain safety standards by laboratories engaged in government-funded research projects on the basis of the "guidelines for the protection from dangers resulting from in vitro recombinant nucleic acids."

Although these guidelines are not legally binding, the government also expects industrial laboratories to comply with the safety standards spelled out in them.

Prof Meinrad Koch of the Federal Health Administration (BGA) in Berlin who was ZKBS chairman from 1978 to 1980 feels there are relatively minor risks involved in genetic engineering experiments. "After all," he says, "these experiments are not taking place in a pretzel factory. There are major technical problems that have to be surmounted before such a genetic engineering experiment can succeed."

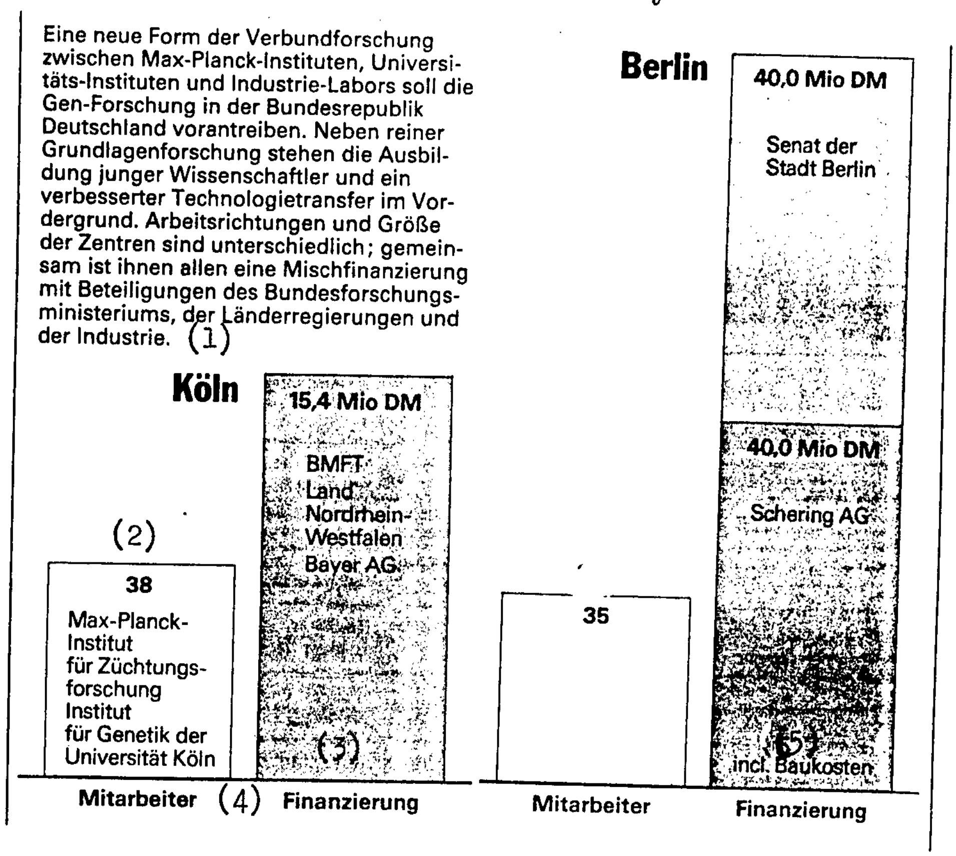
Koch believes that compliance with the necessary safety standards is not so much a question of major investments but one of agreed laboratory procedures and employee training.

But whether someone like Prof Steven Lindow would be permitted to spray his bacteria on FRG farmland, Koch is not in a position to say given the information he presently has. According to the guidelines to be implemented by the ZKBS, both options are possible.

On the one hand, the guidelines state: "the following experiments may not be conducted: the release of organisms containing recombinant nucleic acids" and then one sentence further on: "upon the request of the ZKBS and after an appropriate hearing, the BGA may grant exceptions and either expand or limit the catalog of banned experiments depending on developments in science and technology."

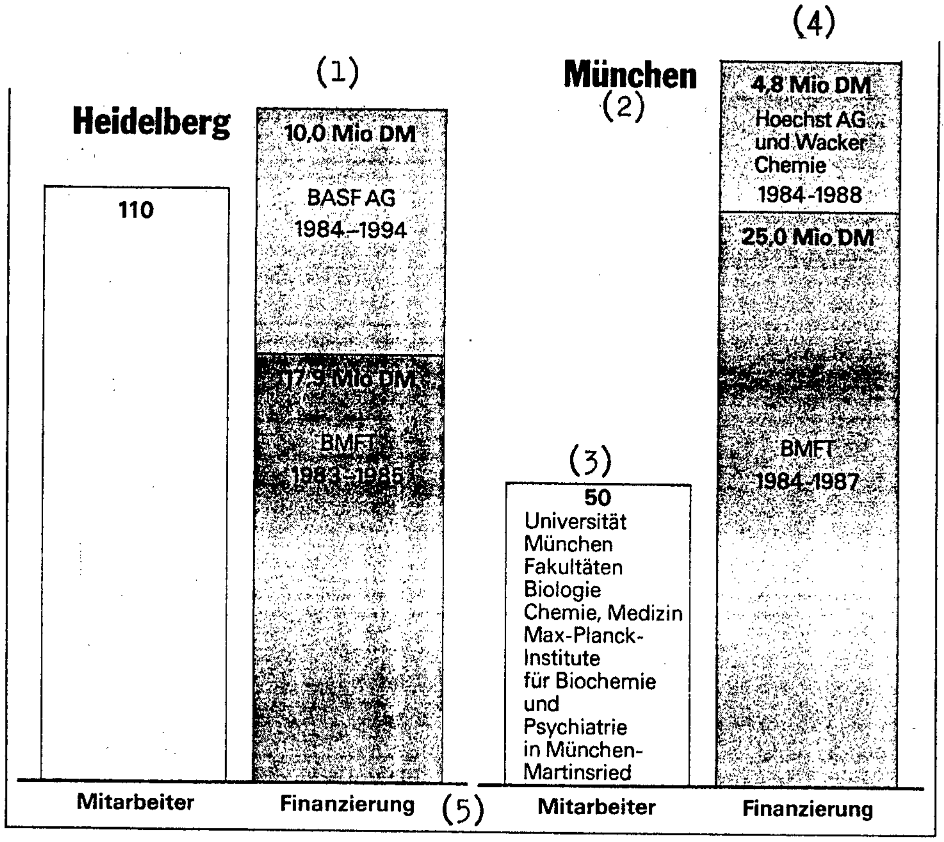
Up to now, however, Koch says, no application for any such experiment in the FRG has ever been received.

Genetic Centers in Germany



Key:

1. A new kind of joint research program involving the Max Planck Institutes, university institutes and industry laboratories is designed to move genetic engineering research in the FRG forward. The program will focus on basic research but also on training young scientists and improving technology transfer. Research goals and size of the different centers vary; what they all have in common is a mixed funding program with contributions from the Ministry for Science and Technology, the Land governments and industry.
2. Max Planck Institute for Breeding Research; Institute of Genetics of the University of Cologne.
3. Ministry for Science and Technology; Land of North Rhine-Westphalia; Bayer AG.
4. Staff; funding.
5. Berlin city government; Schering AG; includes construction costs.



Key:

1. BASF AG; Ministry for Science and Technology.
2. Munich.
3. University of Munich, biology, chemistry and medicine departments; Max Planck Institutes for Biochemistry and Psychiatry, Munich-Martinsried.
4. Hoechst AG and Wacker Chemical Industries; Ministry for Science and Technology.
5. Staff; funding.

Genetic Engineering Industry Research in the FRG

Name and Location of Firm	Research Projects	Partners	Number of Scientific Staff	Products on Market or in Clinical Test Stage
Biosyntech Hamburg	DNA synthesis; gene machines; products	own research	less than 10	yes
Gen-Bio-Tec Heidelberg	DNA synthesis; research contracts for products	own research	less than 10	no
Organogen Heidelberg	immune-regulatory proteins	own research	less than 10	no
Progen Heidelberg	monoclonal antibodies for therapy and diagnostic purposes; vaccines	own research	being founded	no
BASF Ludwigshafen	Plant protection; pharmaceuticals	Heidelberg Genetic Center	more than 10	no
Bayer Leverkusen	Blood plasma proteins; technical enzymes; plant protection; waste water purification	Molecular Diagnostics, Miles (both U.S.A.); Cologne Genetic Center	more than 10	no
Hoechst Frankfurt	Insulin; blood plasma proteins; plant protection	Boston; Munich Genetic Center	more than 10	no
Schering Berlin	Steroid hormones; amino acids;blood plasma proteins	Berlin Genetic Center	less than 10	no
Behringwerke Marburg	Blood coagulant factors; hepatitis-B diagnostic test	Biogen (Switzerland); Hoechst	less than 10	yes
Battelle Institute Frankfurt	Vector development for large-scale fermentation; made-to-order enzymes	Battelle (USA); various medium-sized companies	less than 10	no

Gruenenthal Stolberg	Urokinase	Genentech (USA); Darmstadt Technical Institute	less than 10	yes
Bioferon Laupheim	beta-interferon	New York University; Max Planck Institute for Biochemistry; Society for Genetic Engineering Research	more than 10	yes
Roehm Pharma Darmstadt	Technical enzymes	Darmstadt Technical Institute	less than 10	no
Boehringer Ingelheim	Interferons; blood plasma proteins	Genentech (USA)	more than 10	yes
Boehringer Mannheim	Blood plasma proteins; monoclonal antibodies; technical enzymes	own research	less than 10	yes

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CSO: 3698/462

CIVIL AVIATION

DISCUSSION OF BELGIAN PARTICIPATION IN A 320 PROGRAM

Financial, Regional Problems

Brussels LE SOIR in French 21 Mar 84 p 8

[Article by Pierre Bary]

[Excerpt] As we have already pointed out, Belairbus, which currently holds a 2.3 percent share in Airbus' "A 310," hopes to keep approximately the same share in the new "A 320" program. Financing problems will require participation by the government and the Walloon region, to enable Sonaca to develop and manufacture the leading edges of the wings. Other jobs may be handed over to us provided we increase our investment. This is what the management of Belairbus just told a consortium of Flemish aviation companies, which announced its intention to negotiate a share in the development of the small Airbus.

Our participation in major aviation and aerospace programs was the subject of discussions during a recent statutory meeting of the Belgospace Interprofessional Association. After indicating its delight at the success of the Spacelab and Airane programs, it deplored the tendency of certain large countries to try to take over the major programs without leaving a sufficient technological share to the smaller partners.

Belgospace concluded by saying that our industry should benefit from "industrial fallout" as our country contributes more to the European Space Agency.

Further Details

Brussels LA LIBRE BELGIQUE in French 23 Mar 84 p 2

[Text] Will our aviation industry participate in financing and manufacturing the Airbus A320, the short-range European, 150-seat aircraft which was just officially announced? It's possible--even likely, perhaps--but still not at all certain.

Belgium, which is already participating in the A310 program, is contractually empowered to apply for a share, provided it agrees to make the required investment and is in a position to complete the work entrusted to it.

In Toulouse, the European consortium of Airbus Industry appears convinced that our country will participate in the project and seems to have received clear indications to this effect, from both government authorities and executives of the industries grouped together under Belairbus. However, no final agreement has as yet been signed.

As with the A310, Belgium would be responsible for manufacturing the mobile parts of the leading edge of the wings, equivalent to about 2 percent of the total airframe. Since British Aerospace was responsible for the entire wing unit in the A320 program, Belairbus would therefore be a partner of the British group, as the Belgian share is in some ways taken out of the British share.

Overall, the work would be distributed as follows: 36 percent to France, 31 percent to Germany, 27 percent to Great Britain, and 6 percent to Spain.

Since the program is now officially launched and the Airbus group is anxious for it to pick up momentum--the first test flights are supposed to take place in February 1987--Belgium only has a relatively short period of time to make a decision, if it does not want to see the plane take off without it.

As always, however, things are in danger of dragging on for the usual reasons of financing and community problems.

The ongoing A310 program is expensive, first because sales of the aircraft have not yet reached the "break-even point," but mainly because of Belgium's own problems (Sonaca's situation and its relationship with Belairbus).

Things have reached a point where participation in the A310-300 model is still not decided, because of a shortage of capital to finance the 4 or 5 million needed for development and tooling costs.

The Walloon region has agreed to advance half, but the Belairbus industries say they are unable to finance the rest. A solution will, however, most likely be found, for the sake of "salvaging" the aviation industry.

The situation is further complicated by the A320 program. Flemish industrialists involved in aviation want a larger share , to show that Belairbus is a national company. In the case of the A310, such a claim would have been unrealistic as it would have meant changing partners in the middle of a program already underway.

The problem is apparently different for the A320, since this is a new plane. In reality, though, the problem is virtually the same. The tiny share going to Belgium involves a specific, highly specialized job. To change the structure would most likely be unacceptable to Airbus Industry, as would dividing the program up into a number of small jobs, which would destroy its interest.

In fact, the action by FLAI (Flemish Aerospace Industries) seems to be primarily "psychological." It could probably have a marginal effect on increasing subcontracting by firms in the north of the country with Belairbus' current partners, but it should primarily be viewed as part of a broader context of community negotiations.

All the partners want their strong points recognized and want to win out over the others. The Walloons want a share in telecommunications, the Flemish in aviation, and each one is set on proving "ad absurdum" that it would be unrealistic to duplicate capacities, but the end result will be a confirmation of the current leaders.

This is a rather long detour from the road of realism, but we all know that in Belgium wisdom rarely moves in a straight line.

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FRANCE DEVELOPING COMPUTER AID TO ARTIFICIAL INTELLIGENCE

Paris AFP SCIENCES in French 26 Apr 84 pp 30-31

[Text] Paris--The management of Marcoussis Laboratories, the CGE [General Electric Company] research center, disclosed to science reporters, on 25 April, a research program aimed at developing a computer aid to artificial intelligence [MAIA].

The project, which is being implemented jointly with the DGT [General Directorate for Telecommunications] as regards hardware, has as its target the bringing out on the French and international markets, by 1986, a special-purpose computer for smart systems.

Smart systems, which are capable of duplicating human expertise in a precisely delimited domain, require, for fast operation, "Lisp" machines, so-designated after a specific language that enables the handling of tree-like structures in the same way as conventional computers handle numbers.

These tree-like structures are actually the logical and structured decoding of instruction statements, enabling the machine to make logical choices.

Mr Gerard Guiho, manager of the Data Processing Division at Marcoussis, indicated that the MAIA Program is currently staffed by 20 persons at Marcoussis and 20 others at the DGT. The other partners in this undertaking are the ADI [Data Processing Agency] and the Ministry of Industry and Research.

"This type of system represents a strategic stake of growing importance," commented, for his part, Mr Maurice Magnien, CEO [chief executive officer] of Marcoussis Laboratories.

Lisp machines, which, at equal price, are capable of working much faster on the tree-like structures of smart systems than are conventional computers, and the world population of which, in 1983, was 300 units, are currently exported exclusively by the Americans, subject to required lead times averaging 8 months for export embargo clearances and delivery. The Japanese, for their part, are not exporting their production in this domain.

At present, it is not known which French firm will be producing MAIA, but the machine should cost around 700,000 francs, whereas current American-produced machines are priced close to 1,200,000 francs.

By comparison with a conventional machine of the Digital Equipment Corporation's "VACS" type, which in France, lacking an alternative, is often used for smart-system applications, and very often in scientific laboratories, MAIA should reduce response times by a factor of 100.

Compared with the cost per executed instruction per second for an Apple II microcomputer using "Prolog" logic language, that for a system using MAIA should be 40 times less.

"As of 1986 or 1987," Mr Magnien added, "MAIA will probably be the only European machine of the Lisp type."

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NORWAY'S NORSK DATA SHOWS SHARP SALES INCREASE

Oslo AFTENPOSTEN in Norwegian 14 May 84 p 34

[Article: "Norsk Data: Strong Increase in Orders Received"]

[Text] In the first quarter of this year, Norsk Data received orders to the tune of 302 million kroner. This is an increase of 85 percent as compared with the same quarter last year, when 165 million kroner worth of orders were received. It states in the company's annual report that the company is planning on continued high growth and that 1984 profits will turn out well as compared with the company's competitors.

"Norsk Data is entering 1984 with a strongly improved starting position together with a supply of orders which is considerably larger than in the last few years," it states in the management's report. The management believes that the trend in the European market for minicomputers is propitious for Norsk Data.

The trend is going in the direction of systems with powerful software and advanced programming facilities, something which has resulted in a need for larger computers.

In the annual report is shown a table which shows that 1983 was the 11th year in a row with a growth in sales and earnings. Last year Norsk Data had sales of 886 million kroner and a profit before annual adjustments and taxes of 144 million kroner. The profit after taxes was 129.4 million kroner.

The two companies Norsk Data purchased in Sweden and West Germany are also included in the growth figures. Both the purchased companies show sound profits, but it is reported that both 1983 and 1984 will be a transition period for the West German ND Dietz company. "Both products and organization must be coordinated," it is pointed out. "A considerable increase in the sales staff for the West German market is planned."

After the considerable supply of capital Norsk Data has received from markets in Norway, and now in the last year especially in the USA, the company stands out as exceptionally sound. "Norsk Data's balance seems to be far more sound than what is normal for Norwegian firms," it is pointed out. "Over the course

of 1983 its soundness was brought up to a level equaling that which many American manufacturers of minicomputers can show."

It is reported that net capital, counting conditional tax-free sales, equaled an entire 64.9 percent.

Norsk Data's administration presents in the annual report calculations which show that Norsk Data comes out better than five of its major American competitors as far as its net profit margin and accrual of interest on net capital are concerned, and is on a line with the best as far as net profit is concerned, viewed in relation to the number of man-years which have been invested in the company.

The company's increased strength and good reputation in Europe have made it easier to recruit new personnel, it is reported in the annual report. The company can choose among a number of well qualified candidates for most jobs. At the turn of last year Norsk Data for the first time had more employees abroad than at home. The company had a total of 1784 employees, an increase over the 1047 of a year earlier. Of the additional increase of 737 employees 532 came from the takeovers in Sweden and West Germany.

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REVIEW OF AUTOMATION, ROBOTICS EXHIBIT IN MILAN

Paris INDUSTRIES ET TECHNIQUES in French 10 Apr 84 pp 16-17

[Article by Andre Larane: "Milan: Some Very Special Robots"]

[Text] Some 100 models ranging from the laser-type robot the Scara, all very special robots.

The 6th NC [Numerically-Controlled] Industrial Automation and Robot Show in Milan is turning out to be Europe's most up-to-date robotics exhibit. This is not at all surprising: The small service companies and the large firms, such as Fiat, are manifesting a faith in the future that is unparalleled elsewhere. For the introduction of its Uno in early 1982, the automobile manufacturer inaugurated, at Mirafiori, the most robotized assembly plant in Europe. At Rivalta, it has just completed putting into service four 7-axis painting robots built by the French firm AKR [expansion unknown].

The model exhibited at Milan consists of a 6-axis articulated arm mounted on a piloted translator. It is programmed by learning, with the operator directing the syntaxer toward a motionless body. Thereafter, numerical control adapts the spraying to the variations in speed of the conveyor carrying the pieces to be sprayed.

Three-Dimensional Laser Cutouts

Prima Progetti, a Piedmontese PME [Small- and Medium-Size Business] manufacturing firm, exhibited the first application of a "laser robot" to 3-dimensional cutouts from dished plates. Owing to its extreme flexibility, the quality of cutouts it produces and the elimination of all secondary operations, the system replaces special cutting matrices advantageously... "At least," says Alberto Delle Pane, manager of the Laser Robotics Division, "on test pieces and short production runs." The laser tube is mounted vertically. It moves along that axis. At its base, the beam is transmitted via a lens-and-mirror system to a spatially orientable head. The piece's support itself moves along two perpendicular axes. To ensure an accurate cut, the head must skim the material at a distance of a few tenths of a millimeter.

Deltax, a small Turin-based firm, is offering an alternative for the cutting of 3-dimensional shapes from composite materials. Its materials-handling robot is linked to a water-jet cutting machine. One client uses the system for drilling motorcycle riders' helmets.

The firm also plans to market in Italy the assembly robot manufactured by SCEMI [expansion unknown] (France). This fast, accurate... and expensive robot (400,000 francs for the basic model) is already in use in some national laboratories. It is scheduled to be installed soon in a glass demonstration enclosure at Hewlett Packard (Grenoble). But its principle--a spatially mobile articulated arm--and its cost, render it competitive for the assembly of complex parts involving oblique as well as vertical and/or horizontal insertions.

If the user's requirements are limited to vertical insertions, the Cadratic, manufactured by SORMEL [expansion unknown] (MATRA [Mechanics, Aviation and Traction Company] group), is more attractive. Its head moves along a horizontal frame. It holds up to eight tools programmable along the vertical axis or rotationally. This is the firm's answer to its principal competitor, the Japanese Scara-type robot, which involves an arm articulated in the horizontal plane and a components-carrying gripper that moves up and down. IBM is marketing an improved model, with a gripper programmable in the vertical plane. But the American mammoth makes a Cartesian robot with a spatially orientable and sensing gripper. It is highly efficient and is priced at 1 million francs, whereas the basic Scara is priced at 250,000 francs.

In the field of dimensional measurement and monitoring, at least two "integrated centers" have been introduced. Imperial Prima is offering a 4-axis measuring machine with, optionally, a 4- or 6--feeler-gauge toolhead that is similar to machining-center toolheads. On complex pieces, the operator need no longer interrupt the control program to change feeler gauges. Speroni is also offering a measuring robot, with an automatic feeler gauge changer and a bar-code scanner that identifies the parts-holders.

The disclosures at the exposition have not been limited to the field of automation. Polymotor Italiana (Genoa) is targeting year-end availability of a line of "brushless" motors that could very well set the little world of the machine tool agog. This type of motor, though costly, has excellent performance characteristics and requires no maintenance. It is normally used in the military and aerospace sectors, but its field of applications is expanding. A few months ago, British Aerospace equipped itself with a special 60-meter milling machine for machining aluminum wing spars. The Gamfior (Italy) broach is actuated by a Polymotor brushless motor (70 kW at 10,000 rpm).

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STATUS OF FRANCE'S MACHINE-TOOL PLAN

Paris L'USINE NOUVELLE in French 17 May 84 pp 48-50

[Article by Patrick Piernaz: "Machine-Tools: The Unfinished Restructuring"]

[Text] Moderate results for the machine-tool plan after three years of regrouping. If heavy machines and forming machines are recovering all right, French turning machines are facing an uncertain future.

It is a profoundly changed French industry that visitors at the 13th Biennial Machine-Tools Show will discover in a few days in Paris (Porte de Versailles, 22-29 May). During the three years of implementation of the government-supported machine-tool plan, companies have merged, regrouped, folded. Pierre Gadonneix, head of the Directorate of Mechanical and Metallurgical Industries (DIMME), whom the Ministry of Industry had appointed to take charge of the plan, did not have an easy job and the effects of the plan are still limited.

In 1983, production declined by 3 percent compared with 1982, and sales increased by 4.4 percent in current francs (4.26 billion francs compared with 4.08 billion). "We put an end to the negative trend, and we could hardly expect any more encouraging results," Pierre Gadonneix pleaded, who finally managed to sign development contracts with some 20 firms.

All the same, many regroupings provided for in the plan did not resist the harsh laws of economic realism.

Thus, as far as turning machines are concerned, three manufacturers that were to regroup (Ramo, Cazeneuve and SIM [expansion unknown]) have all filed for bankruptcy. Cri-Dan, which was to take over Muller & Pesant, collapsed and was taken over by the French Heavy Machines (MFL) and the Textron group; Muller & Pesant is now operating under rule of court. Similarly, as far as milling machines are concerned, Dufour (Montreuil) has filed for bankruptcy and will not join Vernier. As far as machines for sheetmetal work are concerned, Colly, which was boasting of great ambitions only one year ago, is now in great trouble; it will soon be taken over by the Swiss company Beyeler.

This amounts to an hemorrhage and raises questions as to the true chances of the French machine-tool industry, which ranks a modest ninth worldwide. Will it continue to loose ground and be overtaken by countries such as Rumania and China? That would sanction the failure of the government plan which was designed to promote France to the fifth rank worldwide, to make it equal with Italy.

Of course, poor market conditions--the market declined by 22 percent since 1981--prevented any appreciable recovery of French production. However, with a decline of 3 percent, France suffered less than the United Kingdom (-16 percent), the FRG (-10.6 percent) and Italy (-10 percent). And the French trade balance even recovered, as our imports declined by 15 percent whereas our exports increased by 16 percent. It will probably take a few more years before the results of the restructuring effort undertaken become noticeable. However, in certain fields, things appear to be off to a good start.

Num: A Profitable European Organization

Take numerical control for instance: a few years ago, Num did not look like much of a match for the Japanese and U.S. giants. Yet, in 5 years, the Telemecanique subsidiary managed to multiply its production by 5 and its exports by 25. And, according to Yves Saulnier, its chief executive officer, with 5,000 control cabinets produced last year, it ranks 5th worldwide, and it also has a truly European organization.

As far as heavy machines are concerned, MFL (584 million francs in sales, 1,420 people), which was formed by the merger of Forest-Line and Berthiez Saint-Etienne, objectively has the means to increase its share of the world market by 4 to 6 percent. Its chief executive officer, Louis Tardy, managed to find quick solutions to two thorny problems: that of the Line business in Albert, and that of Berthiez (closing the Givors plant). Establishing the company in the United States, acquiring Goldsworthy (one of the leading U.S. manufacturers of machine-tools for composite materials), equipping all MFL factories with computer-aided design systems, etc., Louis Tardy acted fast and, above all, he knows where he is going. His major asset is that he was able to start an effort that will continue over several years and bear fruit in 1987 and 1988. At any rate, less than two years after its creation, MFL is one of the five leading manufacturers of large-capacity machine-tools. It is determined to increase its share of the world market by 50 percent by 1988.

Milling Machines: A Clarification

As far as forming machines are concerned, the situation was clarified when Spiertz and Bret, two press manufacturers, joined within the Forming Machine-Tool (MOF) holding. This firm has good products, but the French market in this sector remains depressed, and MOF is fighting to increase its exports to the Soviet Union, Algeria and especially the United States, in order to stay in business.

Exporting is also a must for Bombled and Picot which have become part of the SOFRAMOP [French Picot Machine-Tools Company] holding. Picot (45 people, 22 million francs in sales in 1983) is achieving a remarkable breakthrough: "In 3 years, we took over 90 percent of the market for numerically controlled tubing benders," Bernard Lionet, chief executive officer of SOFRAMOP, explained with obvious pleasure. For Bombled (70 people, 32 million francs last year), profitability will result from the transfer of its "foundry" operations which are now distinct from its "machine-tools" operations.

The situation is also satisfactory at PROMECAM [expansion unknown]: its sales on the U.S. market soared after it signed a cross agreement with Strippit, a manufacturer of numerically-controlled punching machines. PROMECAM export sales rose by 58 percent in 1983 and now account for 48 percent of its total sales (215 million francs).

Metal-Cutting Machines: A Difficult Situation

On the other hand, French manufacturers of metal-cutting machines (grinding and milling machines, lathes and machining centers) appear to be in a far more difficult position. As far as cylindrical grinding machines are concerned, the Clichy-Gendron merger into the French Cylindrical Grinding Machine Company (SRCF) took a long time to implement. Precious time was lost and the Clichy backlog of orders was depleted as months went by, in spite of the fact that the company was well placed on the European market for camshaft grinding machines. The commercial department of SRCF in Villeurbanne will need a lot of knowhow and perseverance to regain the confidence of foreign clients...

The situation remains difficult also for milling machines, as their market declined by 40 percent in recent years. Yet, not all was lost in this specialty, as France has a good hand with Hure, Alcera and Gambin. Yves de Boisfleury, chief executive officer of Amstutz-Levin which controls Alcera and Gambin, believes that he can pull it off by banking on technology (plate changers, skewed-surface machining and, of course, numerical controls).

Specialization in production milling proved a success for Rouchaud, which produces milling centers; despite difficult market conditions, Rouchaud SA, in which SOFIRIND [expansion unknown] has acquired a 33 percent interest, managed to increase its sales by 20 percent in 1983 and it appears to be off to a good start as far as laser-cutting machines are concerned.

French chances appear to be much harder to protect when it comes to lathes and machining centers, a sector in which the Japanese are concentrating all their forces. Take for instance Graffenstaden which produces 40 machining centers per year: how could it expect to compete with Mori-Seiki or Yamazaki which manufacture over 100 per month! And the problem is the same for numerically controlled lathes: firms like Okuma or Mori-Seiki produce 10 to 50 times as many units as their French counterparts!

Catalog Machines: Toward a European Restructuring

The difficulty of the problem and the large investments required to adapt the production plant explain why it took Intelautomatismes (of the Indo-Suez group) such a long time to work out a viable industrial plan for Hure and Graffenstaden, as well as for Ernault-Somua, as abandoning the latter would discredit the whole French machine-tool industry.

France is heading toward a situation where only two or three manufacturers of numerically controlled lathes will remain face to face; essentially Ernault-Somua and SONIM [expansion unknown] (the former SIM) which is about to take over Sculfort in Maubeuge. But this position will prove hard to keep. "To get anywhere near the size of Japanese series, there must be European cooperation," we were told by Telesys, a consulting company which has made an extensive analysis of the situation of the machine-tool industry. Pierre Gadonneix is aware of this: "This is a prospect of current interest, and the government has no objection. We believe that now is the time to sign agreements of this type."

As far as catalog machine tools are concerned, will the restructuring that has taken place in France be continued by a restructuring at European level? We have no other choice, unless we want to see Japanese manufacturers establish themselves one after the other in European countries that will rush to welcome them.

Present Status of Regroupings

Contemplated Regroupings	Present Situation
Metal-Cutting Machines	
- Heavy machines: Berthiez + Saint-Etienne + Forest + Line	Successful regrouping: the MFL holding is controlling two subsidiaries: Berthiez-Saint-Etienne and Forest-Line.
- Catalog machines (milling machines, machining centers + lathes) Hure + Graffenstaden + Ernault-Somua	Partial regrouping: Hure + Graffenstaden into Intelautomatismes. The fate of Ernault-Somua has not been decided yet.
- Turning machines Ramo + Cazeneuve + SIM	These three companies filed for bankruptcy one after the other. Cazeneuve is waiting for someone to take it over; Ramo made a new start with part of its cadres (New Ramo Company); and SIM made a new start under the name SONIM--it could take over Sculfort in Maubeuge.
- Grinding machines Clichy Manufacturing + Gendron	SRCF took over Gendron's assets. It is now in the process of taking over Clichy Manufacturing. The group will operate in Villeurbanne.

- Milling machines and machining centers Vernier + Dufour Alcera + Gambin	Dufour filed for bankruptcy; Vernier took over GSP [expansion unknown] (machining centers). The Alcera-Gambin Company is being created now. The two marketing networks merged in 1983.
Forming Machines	
- Heavy presses Spiertz + Bret	The Forming Machine-Tools holding, which has a majority interest in Bret's capital, will also acquire a majority interest in Spiertz. The regrouping is already operative at commercial level.
- Bending presses and shearing machines Promecam + Colly Picot + Bombled	This regrouping, which was contemplated only tentatively, was never carried out. Promecam is still on its own and has signed a cross agreement with the U.S. company Strippit. As for Colly, it is about to be acquired by the Swiss company Beyeler. A financial holding, SOFRAMOP, is controlling Picot and Bombled. The two companies remain distinct, but have pooled their marketing departments.

Source: L'USINE NOUVELLE

This table does not include other French machine-tools companies which were not involved in regroupings, although the government plan takes them into account. Some of these are INTERTEC [expansion unknown], Rouchaud, Clement-SECC, I2L [expansion unknown], etc.

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BRIEFS

SAGEM FLEXIBLE WORKSHOP AT SNIAS--The SNIAS [National Industrial Aerospace Company] flexible workshop at Bourges is equipped with 60 roller conveyors fed automatically by two CFC [expansion unknown] Linecar trolley cranes. Designed and developed using the most modern and industry-tested electronic and data processing techniques, these wire-guided trolley cranes are controlled by signals emitted by an electric wire buried in the floor. The system's operation and data transmission capability liken it to an active and smart peripheral that contributes directly to the processng of operating data, from which control is derived. The energy requirements of the trolley are supplied by self-contained batteries, the state of charge of which is continuously monitored by self-contained means and displayed on the trolley control panel. This monitoring can be switched to a supervisory system. Each trolley is equipped with photoelectric cells that enable it to choose and optimize its own route by inspection of reconnaissance charts attached to the floor. In addition, a motion-pickup arm enables activation of the roller conveyors upon coming into contact with them. Safety monitors identify the dimensions of the conveyors and ascertain whether or not the conveyors are free. Remotely transmitted signals enable the machines to choose the trolley crane to be used. The entire flexible workshop system is operated by SAGEM [Company for General Applications of Elctricity and Mechanics]. [Text] [Paris INDUSTRIES ET TECHNIQUES in French 10 Mar 84 p 56] 9399

RENAULT ROBOTICS FACTORY--Under an agreement with Datar, Renault Automation, under which all the state-owned Renault company's CIM [Computer-Integrated Manufacturing] activities are grouped, will install an industrial plant devoted to robotics. It is scheduled to go into service by 1985 and is expected to create between 150 and 200 jobs within 5 years. Renault will be investing some 30 million French francs in this plant. While dedicated initially to the design, fabrication and maintenance of robotized systems, this plant will also serve as a pilot for the setting up of long-term training courses in industrial data processing. [Text] [Paris ZERO UN INFORMATIQUE HEBDO in French 2 Apr 84 p 9] 9399

CSO: 3698/420

BRITISH FIRM HAS NEW ALUMINUM-LITHIUM ALLOY

Paris L'USINE NOUVELLE in French 10 May 84 p 57

[Article by Dominique Benasteau: "Aeronautics: A New Aluminum-Lithium Alloy"]

[Text] British Alcan will soon be in a position to produce aluminum-lithium ingots weighing 3 tons. These new alloys now waiting for official approval will enable aircraft manufacturers to achieve precious weight savings.

"We are now casting ingots weighing 1,000 kg. They have the same section but are shorter than the 3-ton ingots we will be able to produce as soon as our 5-ton furnace is operational, i.e. before the end of next year," we were told by Colin Baker who is in charge of aluminium-lithium projects at Alcan International. And he is already thinking about the next stages: "Five-ton ingots with 25-ton melting equipment."

A progress that is justified by the undeniable interest offered by these materials: a density 10 percent lower and a modulus 10 percent higher than those of competing aluminum-copper (2014 and 2024) and aluminum-zinc (7075) alloys. That means a 10 percent weight reduction by a mere material substitution, or a 15 percent reduction if the part is redesigned or specially designed. Advantages that make up for the (three times) higher price per kilo.

David Holmes (Alcan Plate) is also confident that "the first parts will fly in 1986." Yet, the initial research, which was carried out at the Fulmer Institute, dates back only to 1971. British Alcan, created in November 1982 jointly by British Aluminium and Alcan, had the benefit of the efforts made by the two partners since 1977 and 1980.

France is also represented in the competition, but with a "lag": at the 1983 Bourget Show, Cegedur was talking about 50-kg ingots when British Alcan was already publishing results obtained with 500-kg ingots... The French

decision to invest in a foundry that could produce 5-ton ingots is still pending; and the facility limited to 1,200 kg should start in June-July. These stages are all the more important as these alloys are intended for the aeronautical industry and must therefore undergo gruelling tests to receive official approval. British Alcan has already obtained provisional specifications from the Royal Aircraft Establishment for its A and B grades of the aluminum-lithium alloys, and has sent samples for evaluation to some 50 companies. Negotiations on a fatigue-resistant grade have taken place.

An exhaustive evaluation of the two grades already produced covered production processes (rolling, drawing, extrusion, etc.) and fabrication methods (forging, machining, bonding, etc.). Certain points must still be clarified and checked on larger ingots, but aluminum-lithium alloys as a whole are behaving like traditional alloy grades; the presence of lithium is said not to cause any major problem, which justifies the selection of this alloying element, which is eight times as efficient as magnesium.

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ERRATUM: This article republished from JPRS-WST-84-015 of 14 May 1984 to change certain translated terms.

MICROELECTRONICS

THOMSON SEMICONDUCTORS TO SPECIALIZE IN SEMICUSTOM IC'S

Paris ELECTRONIQUE ACTUALITIES in French 17 Feb 84 p 17

[Article by F. Grosvalet: "Thomson Semiconductors Attempting To Multiply Their Semicustom IC Sales by 5 This Year"]

[Text] Grenoble. The Special Circuits Division [DCS] of Thomson Semiconductors, created in 1981, and operational since the spring of 1982 (see ELECTRONIQUE ACTUALITIES of 5 April 1982) is changing its mission. Whereas its specialty until now was the design of special circuits (either true custom or gate arrays), it is now devoting its activities to semicustom IC's only, either gate arrays or standard cells, both for the Thomson group and for the external market.

DCS's ambition is to use the Grenoble center, to which is or will be connected a network of distributed terminals through modems as an efficient means of access to the field of bipolar, linear and CMOS gate arrays and standard cells. The division is already using a decentralized design center in Paris (the La Boursidiere Center) and one of its distributors should be equipped with terminals connected to the Grenoble VAX 11/780 during the current quarter.

In the area of standard cells, Thomson Semiconductors intends to associate with each family of gate arrays circuits a family of standard cells using a similar library, in order to offer the user a choice. The latter will therefore have the capability of starting a gate array project, and finally switch to a library circuit if this is preferable.

The first stage in this area should be completed in mid-1984 with the introduction of a 3 micron CMOS standard cell with 40 functions in the library, including RAM and PLA.

According to DCS, the demand for semicustoms is beginning to pick up in France, and the company is expecting to multiply its sales in this area by 4 to 5 in 1984 (since 1982, it has already accomplished 40 customizations, 15 of them for customers outside the group.)

A Family of 2ns 2μm [micron] CMOS Gate Arrays To Be Available at Year-end 84

In the area of uncommitted logic arrays Thomson Semiconductors, today marketing two ECL arrays with 500 and 1,000 gates and a 1.2 ns delay per gate (AMCC second source) and [four 3-micron CMOS arrays with one metalization layer, 360, 648, 1080 and 1458 three-input gates respectively] (equivalent to 540 to 2,250 2-input gates), and 3 ns delay per gate is expected to introduce an HBIP II bi-polar family, and a 2μm CMOS between now and the end of the year.

The first will include 1000, 1700, and 2500 gates characterized by an internal propagation time of 1 ns. These internal ECL arrays will be externally either TTL-LS or ECL compatible. The first to be introduced should be the 1700-gate model in mid-1984.

In the CMOS area the HCMOS II family (from EFCIS [Research and Fabrication of Integrated Circuits] in 2 micron technology with two metalization layers is expected to be introduced at the end of the year.

It will include 2000 to more than 3000 gates with a propagation time of 2 ns per gate. DCS is starting with a high level of integration for its 2 micron CMOS family without overlap with the current 3 micron line family since the 2 series are intended for totally differents markets. The latter, in particular, should be reserved for low-cost applications with low complexity (it is interesting to note, by the way, that in this area, the most used array is the one with 1000 gates).

Still in the logic area, the company is expecting to market a 2 micron (μm) bipolar-technology STL family (both gate arrays and standard cells), but not before 1985.

In the linear area Thomson Semiconductors, currently marketing two 20V, 550 MHz Polyuse arrays integrating 424 and 800 components (the latter introduced at the end of last year), hopes to market one new linear gate array every 6 months. The first stage in this strategy will be accomplished in April or May of this year, with the introduction of the 40 V Polyuse integrating 250 components (this gate array will be quite similar to MCE's 40 V model).

A 400-component 20 V analog bipolar array with a 2 GHz switching frequency is also expected to be introduced in 1984.

As far as customization assistance is concerned, Thomson Semiconductors is offering a varied array of tools and services ranging from diffusion or custom mask-design to a complete personalization study starting from specifications, a logic diagram, timing charts, or even a mock-up with standard components.

In the case of a design to be carried out by a user, the company offers CAD tools (software for digitization, placement and routing by Silver Lisco and EPILOG logic simulation software by EFCIS) which allow him, either at Grenoble or from a terminal connected to the center, to design his circuit up to logic

simulation, and to define test sequences. From that point on, 4 weeks are required for the first samples to be available (one week to finalize the design, one week for mask design, one week for processing, and one week for testing).

DCS has very powerful design and test tools in Grenoble (40 MHz, 144 channel Genrad GR 16 and Sentry 16). Packages currently available range from the 16-pin DIL (plastic or ceramic) to the 94-pin Fakir packages (144 pins by the end of the year), including ceramic and plastic chip carriers (Surpicop type capable of being soldered on printed circuits).

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CSO: 3698/336

SCIENTIFIC AND INDUSTRIAL POLICY

PRODUCTS, STRATEGY, MANAGEMENT OF FRG'S SIEMENS ANALYZED

Paris L'USINE NOUVELLE in French 10 May 84 pp 46-53

[Article by Claude Amalric: "Siemens: From Computer-Integrated Manufacturing to Office Automation"]

[Text] With office automation, Siemens is closing the only remaining gap in its arsenal of control equipment. A difficult mission for a clumsy giant? Not so, as all it has to do is regroup where others must create.

Monolithic and over 100 years old, as stable and rigid as the products it manufactures, but unable to react rapidly and therefore threatened to die: it has all been said and proven. And Siemens has never refuted anything, concealing its disapproval of these "bad manners." Actually, very few manufacturers, especially of that size, manage to be at the same time as omnipresent and as discreet. A must, when one draws one's substance from markets as heavily protected as the telephone, radio-relay systems, radars, heavy medical equipment, electrotechnical systems, data-processing; and especially so in Europe. There is still a wide gap between the regulations issued in Brussels and prevailing national protectionisms.

Siemens's power determines the behavior of its marketing agents. Its salesmen will slip away as soon as the contract is signed. This attitude comes quite naturally to the Germans, as they are more inclined to work in the shadow than to talk about what they are going to do.

With a personnel of 313,000 in over 100 countries, generating sales of 39.5 billion deutsche mark in 1983, Siemens demonstrates that fact in the best possible manner: by getting richer, in spite of the crisis that affects its sectors of operation. Last year, its net profits rose to 802 million deutsche mark. A figure that continues a steady progression curve--steady that is except for the year 1981 when profits dropped to 1975 level, i.e. 507 million deutsche mark. Nothing to panic about. Especially since Siemens's equity capital--the gold pile on which it is sitting--exceeded 9 billion deutsche mark at the time!

Its equity capital was estimated at 10.8 billion last September and is expected to reach 11.5 billion later this year. If we add to that securities and current assets, we get close to 17 billion deutsche mark, i.e. 51 billion

French francs... These figures should be considered carefully before attempting to analyze the group's chances of success. A fortiori, before questioning its ability to cope with the rapid mutations taking place in its traditional or new sectors of operation. If it has not always been quick to act, Siemens has got the means to take its time thinking things over.

Essentially a Systems Manufacturer

There are two other considerations we should bear in mind. Of all the groups of its size, Siemens is still the one with the deepest roots in Europe, where 84 percent of its personnel is working, where it invested 80 percent of its 1.7 billion deutsche mark of investments in 1984 (see diagrams) and where it realized 64 percent of its total 1983 sales. But above all, Siemens is German: 44 percent of its sales, 63 percent of its investments and 68 percent of its personnel are in the FRG, representing about one fourth of all of the country's industries built around electricity.

Finally, Siemens is a systems manufacturer; the products it develops and markets are designed primarily for its internal use. As its components meet the requirements of potential customers, they are sold commercially in a second stage. Because they are successful, the captive market share ends up being rather small. This analysis, which is Siemens's, agrees with available accounting data. As its total catalog includes over 200,000 items, the German giant is often considered as a manufacturer of individual components or equipment, whose commercial reactions have been far too slow until now. Although this analysis is true in the case of products, it is mistaken when it comes to systems, as these are far less subject to change than their components. It also brings us to compare Siemens with Philips.

Over the decades, the other European giant, the Dutch Philips--which is mainly consumer-oriented--has established a highly-decentralized organization well suited to that type of market. On the contrary, Siemens, the professional, concentrated its expertise in Germany itself, the birthplace of electrotechnology and telecommunications, in which it was a major pioneer. The same difference is found in their respective manner to approach customers: Philips is scattering its brands behind national companies; Siemens is presenting itself squarely.

The distinction between these two manufacturers which are often compared--and which besides compete in many sectors, e.g. the medical, electronic components, telecommunications or lighting sectors--is not secondary: despite definite similarities, such as their age, size, careful management and long-standing cooperation on various matters, the criteria that can be used to assess the former are not always suitable for the latter. Reaction time is one of these criteria.

Developing a New Marketing Strategy

At least, this was the case until now. But in the short term, the two firms are going to confront each other on the still ill-defined field of office automation, representing approximately one third of their respective opera-

tions. Office automation, which uses computers and networks and is supported by extremely complex electronic components, could not leave them indifferent. Next year, Philips is going to concentrate its divisions involved in that sector into a systems design-and-manufacturing pole; the main problem for the Dutch firm, which until now has been more at ease with products, is to tackle systems. For Siemens, which just completed such an operation, it is no more than an extension of its field of highest expertise: process control. Yet, according to its chairman of the board, Karlheinz Kaske, it has one problem: "to accelerate the conversion of research results into products and services." And to develop a marketing strategy that will be radically new for the firm. This is no small task, and it will raise many questions within the company. So much so that we may well ask: with its heavy and well broken-in organization, and century-old habits acquired on stable markets, will the electrotechnical Siemens manage to become a leader in office automation as it ambitions to do?

Actually, this field which encompasses so many other fields is an implacable test of the ability to survive in tomorrow's world for all those who will tackle it. It will put a great strain on their potential for research, industrialization, marketing, and on their ability to cope with extremely rapid changes in all these fields. Therefore, the resulting overall performance will depend as much on human flexibility as on the means at their disposal.

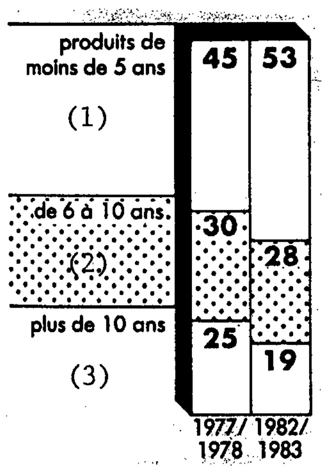
You cannot get around this market. Estimated at 26 billion deutsche mark worldwide in 1982, including 80 percent in Europe and 20 percent in the FRG, it is progressing at the rate of 14 percent per year, with a peak of better than 20 percent for personal computers; terminals and photocopiers hover around 10 percent. Siemens, which accounts for less than 3 percent of the world total (but for 7 percent in Europe and over 20 percent in Germany) should pull itself together. For its competitors are called IBM, accounting for 56 percent of all data processing across the Rhine; Olivetti, which is rising steadily; and even Bull (6 percent in Germany). Not to mention AT&T and Philips.

Very Satisfactory Results in Data Processing

"The first is not very active in our country, but its agreements with the second may prove a cause for concern." Agreeing with the general opinion on this subject, Horst Edgar Martin, marketing director of the telecommunications division, is thinking of the PKI [expansion unknown] subsidiary of Philips. As for Nixdorf, whose star is rising especially in the United States, it may be in Siemens's way where certain products are concerned. In passing, Horst Edgar Martin pointed out how much importance he attaches to the French market, "on which we are not yet very well represented." But measures are being taken to change that... Forewarned is forearmed.

Of the six sectorial divisions of the German group, two are more particularly involved in office automation: the information technology division (data processing) and the terminals and networks division (communications). It is quite logical to add to these the components division and its integrated circuits.

Accelerating Growth



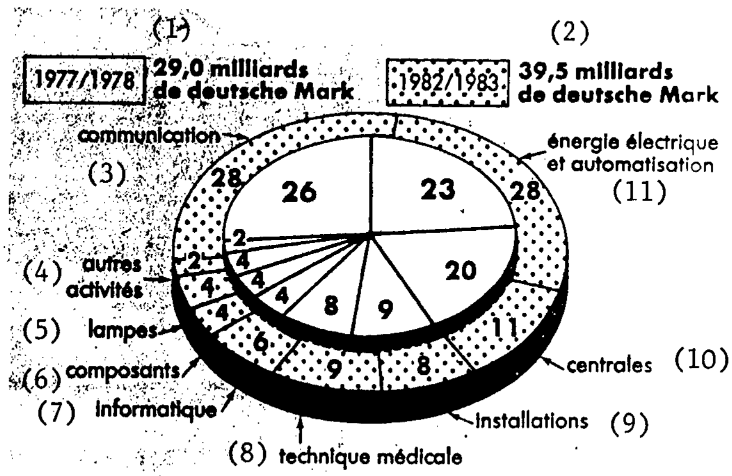
Innovation (In Percent of Sales)

Each year, the proportion of recent products in Siemens sales increases faster.

Key:

1. Products less than 5 years' old
2. From 6 to 10 years
3. Over 10 years

Expanding Automation



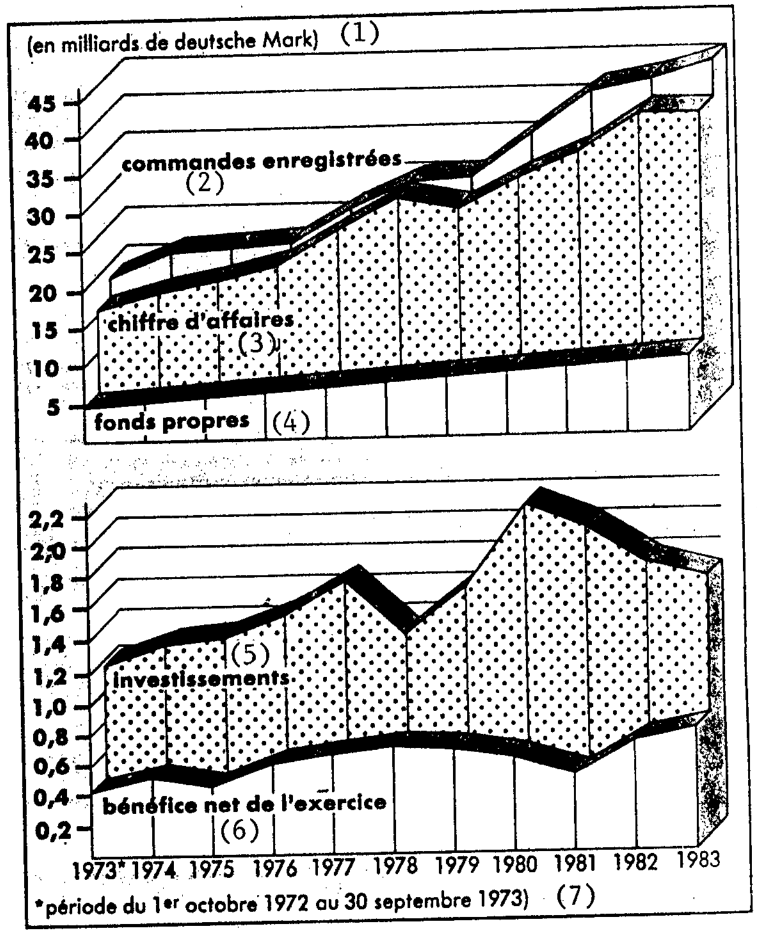
Breakdown of Sales per Sector of Operation (In Percent)

The strong growth of process control automation has increased the shares of the energy divisions from 23 to 28 percent of the total. The same trend prevails with respect to communications. This was the reason for the regrouping decided by Siemens.

Key:

1. 29.0 billion deutsche mark
2. 39.5 billion deutsche mark
3. Communications
4. Miscellaneous operations
5. Lamps
6. Components
7. Data-processing
8. Medical technology
9. Installations
10. Power plants
11. Electric power and automation

Ever Richer...



As can be seen from these diagrams, Siemens is booming. They also show how the firm reacts when its profits drop: it invests!

Key:
1. (In billion deutsche mark)
2. Orders received
3. Sales
4. Equity capital
5. Investments
6. Net profit for the year
7. From 1 October 1972 to 30 September 1973

Last year, data processing was a great satisfaction to Siemens. After years of losses, the division finally achieved "a substantial profit," with sales of 2.7 billion deutsche mark, i.e. 17 percent more than in 1982: the highest rate in the group, in which data processing accounts for 6 percent of all operations. Orders (2.5 billion, i.e. a 10 percent increase) are another positive point. One reason for that success is that production and sales were rationalized, leading to a 35 percent productivity gain within 2 years!.

Business is not quite as good for the communications division, the historical heir to the first teleprinters invented by Siemens (teletype), which themselves were derived from the index telegraph patented by the founder in 1847.

Eleven billion deutsche marks in sales, i.e. 28 percent of the total, that is quite something. It means stability, in spite of [as published] the adoption of the EWSD [expansion unknown] digital automatic switching system by the German Federal Post Office and by 13 countries, which strengthened Siemens in its position as the fourth public telephony company in the world, and Western Union's adoption of the packet-switching system, which will open the U.S. market to this network. Alone, communication terminals, e.g. printers, are with it. Laser printers, a Siemens specialty, account for 50 percent of the European market and 15 percent of the world market for these products.

The third constituent of autonomy in office automation, the components represent 4 percent of all sales, with 2.2 billion of deutsche mark last year. Actually, this is a division with 22,700 people employed in 20 factories throughout the world, producing magnetic materials, microwave tubes, solar cells, etc. Integrated circuits account for 23 percent and miscellaneous transistors for 24 percent. As far as integrated circuits are concerned, the company policy is set by Karl Heinz Beckurts, member of the board in charge of the group's research: "Since 30 to 50 percent of our products will contain microelectronic components, we must be a leading supplier in this field and, therefore, we must have access to the most advanced design and production methods and processes." To be competitive, first, within the company: "The divisions are obligated to do all they can to improve their results. For them, we are just one supplier among many others, and we are given preference only if we can offer equal performance and prices..."

Josef Koeller, in charge of sales at the components division, is not afraid of competition: "We are just as good as the others. We intend to catch up with them. The Americans are producing twice as many integrated circuits as they consume; the Japanese are having an excess production of 10 percent or so. But Europe is consuming twice as many integrated circuits as its factories will produce; therefore, we must double our production."

A "Small-Steps" Policy That Pays Off

Coming from another manufacturer, it would make us smile. But Siemens has what it takes. Plus the determination. In Villach and Regensburg, 200 million deutsche mark invested in the production of 64-K memories make the firm the only European producer of that product; another 400 million invested this year will make of the German company one of the very few companies in the

world to market a 256-K memory by 1985, and work on the 1-megabit memory is already well advanced... Will the positions thus taken prove ruinous? "Profitability is for 1985," we were assured by Josef Koeller. That will quite probably be the case, although the cost of the pilot production line reached 20 million deutsche mark.

Advancing one small step at a time while others are rushing without knowing very well where they are going--heading for resounding successes and failures--Siemens, among other things, has developed a photographic method to transfer one chip at a time on each silicon wafer instead of processing the whole wafer at once. This production stage may then take longer, but the precision is such that the production yield of the complete cycle is improved. Better still: it thus becomes possible to retain traditional optics to go below one micron, a guarantee of very high integration. And Siemens seems to be the only one which can do it. By daring to go slow, it may end up as a winner. By a wide margin.

There is no secret involved: to achieve such results, you must look for them. In 1983, 3.5 billion deutsche mark were spent on research and development, i.e. 9 percent of sale. Note that these expenditures were self-financed to 94 percent (96 percent for non-nuclear research and development), as the German government is usually sparing of such subsidies. "Actually, we are the ones who help with government projects, to which we contribute the ancillary studies we are carrying out," Dieter Dorn, the group's assistant research director commented with a wry smile. To him, it is just a detail! What counts is that, in 1967, 38 percent of the products sold by the firm had been generated in the 5 previous years, and that this ratio rose to 45 percent in 1978 and 53 percent in 1983! This explains why 30,000 people are employed in research and development at Siemens.

Engineers and Scientists in Control

A useful precision: 86 percent of that personnel are working in divisions, and are practically in the field. Only 10 percent of the research personnel is working in central research laboratories at Munich-Perlach or Erlangen. "We do have a problem coordinating this highly-decentralized research. But it is necessary; for the divisions are responsible for their future products. That way, their salesmen can report directly to the designers on customers' problems and market requirements." Dieter Dorn emphasized the practical aspect of most research. Research on productivity and processes is done at the Perlach laboratory, in relation with the divisions and the needs of the units. "Our philosophy originates on this base," he concluded.

Data processing, networks, hardware, research: to tackle office automation, Siemens has more trumps than nearly all its competitors, with two or three exceptions, one of which is IBM. But what about the organization and the men?

Let us say it right away, the organization will follow. In certain respects, it is impressive. For instance, of the 20 board members, 14, including the chairman, are engineers or scientists! Fifteen percent of the personnel as a whole are engineers or technicians. And that proportion is increasing

rapidly since this ratio is expected to reach 17 percent around 1990. These figures are one more key to the cool and self-confident attitude of Siemens.

When the board meets--every month--it is to arrive at a consensus. Large investments are planned at board meetings. "The divisions still make most of their decisions themselves. The system is flexible and allows for rapid decisions when needed," according to Hermann Franz, member of the board in charge of foreign sales.

To relieve the divisions--and also to coordinate overall operations--five central departments (finance, management, personnel, technical, sales) are taking care of day-to-day management. This is essentially how Siemens operates. Smoothly, through discussions among cadres with similar backgrounds and with a long practice of the corporate apparatus.

Regrouping Forces in Office Automation

However, technical expertise is not all. How does this smooth-running organization cope with mutations, especially when the rate of change is accelerating or even when forecasting is inadequate, as is the case today for all technologies and all markets of the future office automation industry? An answer to this question was just given. On 1 April 1984, the whole section of the telecommunications division involved in office automation (terminals and private networks) was transferred to "information technologies," which was then renamed "communications and data processing."

This regrouping stems from a realization of the obvious: every year, the overlap of data processing, networks and communication peripherals is increasing. It was estimated at 5 percent for this year, and is expected to reach 17 percent by 1987! It was high time to react. According to Hermann Franz, the impression left is that of a routine local adaptation rather than a revolution. "We had a similar experience with nuclear power plants. Provisional groups coming from the two parties to be merged were formed. Their job was to take care of new products in their fields of expertise. From marketing to manufacturing."

Which Type of Marketing?

Operating independently, like internal engineering micro-companies, these groups have no special structures, as they are destined to disappear. One year before the merger took place, it was prepared by other mixed groups. "Five years ago, to make sure that they operated properly, we would have needed an outside consultant," Horst Edgar Martin pointed out. "But attitudes have changed and everything went off smoothly, as each was familiar with the other's tasks." The new management, which is in favor of the principle and practice of quality management--members of the board are making factory audits--is thus reaping the rewards of its action, the first effect of quality being to tear down partitions within the enterprise. Twenty-seven thousand people were affected by the merger, without any inconvenience to customers, according to Horst Edgar Martin.

One of the unknowns of the emerging office automation is the shape its marketing is to assume. Should the company sell only to manufacturers, wholesale dealers, retailers, or even directly to the public? "Like everybody else at present, we have no clear idea on the subject yet," Hermann Franz told us. "The ideal would be for a specialized trade to develop." In the meanwhile, Siemens is making an experiment. Since the beginning of this year, a Hanover microcomputer dealer is selling to the public printers, telephone peripherals, word-processing systems and telecopiers of the Siemens brand... "This is the solution we would prefer: a dealer with our technical support. But we are also considering other possibilities; for instance, the creation of 'Siemens shops' or, on the contrary, merely using our present network." Final assessment and selection of a marketing method to be made about one year from now.

From the office to the workshop, the number of rupture points is decreasing. Tasks may differ, but they are processed with similar tools. Office automation here, computer-integrated manufacturing there: both are managed by a computer through a cable network. The terminal may be a printer, a console with a display screen, or a machining center: it does not matter. From the computer-aided design equipment of the design-and-engineering department to the programmable controller which manufactures the parts, and to the machines which assemble them and test and package the finished product, the network can be continuous. It includes inventory management, quality management, accounting, order processing: in a word, everything. This is why it is so important to control the whole.

Expertise in all fields

Of all the manufacturers interested in this concept, of which "tomorrow's factory" is only a part, in spite of all the problems that remain to be solved, how many are in a position to approach it as a whole? This is precisely Siemens's chance: it has expertise in all the fields. From the component to the system is not just a slogan for it. For instance, it just completed automatic assembly workshops for all car manufacturers in Germany, except Ford. Siemens's reasoning? Let us first use at home what we are planning to sell. After a few years' work, Siemens's inventories declined by 10 percent in two years, with a corresponding increase in its sales. "A few seminars and terminals everywhere," as Hermann Franz summarized it. A heavy investment. But this reduction amounts to a few billions of deutsche mark. At an annual interest rate of 10 percent, it is a saving of the order of 100 million deutsche mark every year. This is only one example. It shows the company's ability to tackle this type of obstacle, one of the hardest to overcome among those that spike the way to global automation.

In this context, the regrouping of all computer-integrated manufacturing operations within the larger energy division (77,000 people, 11.1 billion deutsche mark, 28 percent of Siemens) assumes an importance that had gone unnoticed until now. It took place on 1 October 1983 and was similar to the data processing/communication regrouping that took place soon afterward. As in that case, the market aimed at is increasing much faster

than the markets of the remaining divisions involved. Thus, production automation is growing at the rate of 15-18 percent per year, and computer-aided manufacturing and design systems (CAD/CAM) at the rate of 20 percent; these figures are close to the figures for general data processing, whereas the energy division is expecting a growth of 7-8 percent per year for its other activities.

As far as the sectorial development of the new computer-integrated manufacturing department is concerned, Siemens is already in a good position or rising rapidly. As always, it finds preliminary support on the German market: 34 percent of process-control computers, 40 percent of numerical controls, although Siemens ranks second worldwide in this field, as in robotics and sensors. Keeping a watchful eye on the U.S. market, which the firm entered late "but which is going to grow from 7 to 13.4 billion dollars within the next 5 years," according to Siegfried Waller, in charge of computer-integrated manufacturing. He believes that production automation is ineluctable. The factory of the future? "The others are talking about it... we have the software packages for it." We have heard that before. And it is probably true, too.

In this particular case, it may also be true for IBM, which is showing increasing interest in the workshop; the 9000 computer it just introduced is halfway there. A tough business for Siemens which, on the other hand, has an agreement to purchase disk memories from the U.S. company, while already selling integrated memories to it. Another competitor to be feared: the General Electric subsidiary specializing in computer-integrated manufacturing, GETC. If IBM is essentially a computer manufacturer, GETC is backed by General Electric's electrotechnology, its determination to sell systems (even if it means buying some components from Siemens), and at least a proclaimed aggressiveness. Plus a European center in Frankfurt; practically at Siemens's door!

Process Control: Siemens Has It All

General Electric had total sales of 27 billion dollars in 1983. But Siemens also has an installations division. High-voltage cables, lighting (Osram ranks fourth worldwide), any electrical equipment: it provides technical and material support for engineering--and represents 8 percent of Siemens. It covers the whole range with its nine Berlin factories, including the Dynamo Works, the pioneer and world champion as far as very large rotating machines are concerned, to which engineers are now for the first time adding electronics (so that it will become possible to control them directly through a computer). It covers all the fields involved in fully automated systems, the ultimate goal of the industry, and can offer services for production, distribution, design, etc. To realize this future prospect, there is one prerequisite: each part must be compatible with all the others to make a consistent whole.

It is in this context that the Munich firm just reorganized its services. It did not have to create anything; all it had to do was to reshuffle its cards. Office or workshop terminals, networks, software, large and small

computers, processes and machines, from the control knob to the giant alternator, including integrated circuits: not one trump card is missing in this hand, the balance of which is probably unique. What use will the company make of it? The next few years should show to what extent we were underestimating Siemens as a control-equipment manufacturer.

Berlin, a Mecca of Electrotechnology

With 15 plants employing 24,000 people, Siemensstadt (Siemens town) is the largest concentration of facilities of the firm whose headquarters are in Munich. For Siemens was born in Berlin and is deeply rooted there: 3 billion deutsche mark since 1945; 200 million per year at present. "And we are going to keep it up," Dirk Forkel, who is in charge of the group, insisted. "Especially in advanced technologies which account for half of our operations in Berlin." An act of faith in this overcrowded town where every square meter is already taken.

But here the name of Siemens is especially closely linked to the origins of electrotechnology. The Dynamo Works, for instance, are the oldest railroad equipment factory in the world: its first electric locomotive was produced in 1879! It is also the factory that holds dimension records: 0.1 MW for an hydraulic power-plant generator in 1939; and 805 MWA in 1981 for the Amazone. A machine with a diameter of 20 m. Colossal! "We are the world leaders for this type of equipment, as well as for large motors," Leon Lehmann, technical director of the Dynamo Works, told us. "We hold 25 to 50 percent of the accessible market. For protectionism plays to the hilt for this type of equipment." As a result, the factory exports up to 80 percent of its production. "That is too much: to be stable, we should sell one third in Germany."

Seniority does not mean that you cannot lead in advanced technologies; insulators are one of Siemens's strong points. As well as the introduction of thyristors in large rotating machines: "In that field, we are 3 to 5 years ahead of our competitors who are only just beginning." That is why 13 to 14 percent of the 250 million deutsche mark of the Dynamo Works' sales are spent on research and development. The results pay off.

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CSO: 3698/438

NORWEGIAN SAVINGS BANKS FORM VENTURE CAPITAL COMPANY

Oslo AFTENPOSTEN in Norwegian 18 May 84 p 34

[Article by Thomas Knutzen: "Savings Banks in North with Venture Capital Company"]

[Text] Norway has gotten its first regional venture capital company. Eleven savings banks in North Norway are uniting to start a company which will enter the ownership side of new industrial projects with considerable growth possibilities, but where there is also high risk. Nord-Norsk Venture A/S [North Norway Venture Capital Company, Inc.] is to have 10 million kroner of share capital and have its administration affiliated with the securities division of Sparebanken Nord [Northern Savings Bank] in Tromsø.

The company will be formally founded later in the week and a board of directors will be elected, in which 5 out of 10 members will come from research quarters in North Norway. In addition to gambling on those growth industries which other venture capital companies are also looking up, such as electronics, computer technology, telecommunications and bioengineering, Nord-Norsk Venture is also planning to become involved in the breeding of fish, aquaculture.

Assistant Bank Director Tor Laegreid of Sparebanken Nord tells AFTENPOSTEN that Nord-Norsk Venture already has several projects to evaluate. He estimates that the company will have involved itself in a couple of, perhaps three, projects before the end of the present year. Laegreid does not rule out the fact that Nord-Norsk Venture will be able to enter with relatively large sums several companies, and states that the 11 owners have not taken a position in advance regarding possible expansion of the share capital later.

Those behind this will not be adverse to considering a broader range of owners if this should become appropriate. However, at the start this is an initiative from the savings banks in North Norway, Laegreid says.

Laegreid says that they have proceeded somewhat cautiously because there is stiff competition for projects and relatively few projects in North Norway. However, he figures that there is fertile soil for a company like Nord-Norsk Venture in the industrial development at present, especially in Tromsø, Bodø and Mo.

Nord-Norsk Venture is planning to become involved in those companies in which owner shares are taken, at the management level or by offering consulting assistance. The new company thinks it can supply expertise in product development, marketing and sales, administration, economic and strategic planning.

Laegreid does not ignore the fact that Nord-Norsk Venture can also bring in other partners who can enter current concerns with private capital, if the demand is greater than what Nord-Norsk Venture itself can or will provide for.

The banks behind the new company are Narvik Sparebank [Savings Bank], Bodø Sparebank, Harstad Sparebank, Vaagan Sparebank, Sortland & Øksnes Sparebank, Mo Sparebank, Helgeland Sparebank, Alstahaug Sparebank, Hemnes Sparebank, Fauske Sparebank and Sparebanken Nord.

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CSO: 3698/429

SCIENTIFIC RESEARCH, INNOVATION ZONE PLANNED AT STRASBOURG

Paris LES ECHOS in French 24 Feb 84 p 12

[Article by P. M.: "A Zone of Innovation and Scientific Research"]

[Text] Like Philadelphia, Los Angeles, Heidelberg or Grenoble, Strasbourg has decided to establish a park for scientific and high-technology activities, called ZIRS (Innovation and Scientific Research Zone). One of the main promoters is Rene Uhrich, general director of the Strasbourg Chamber of Commerce and Industry, assistant to the mayor and vice-president of the Urban Community; he and the other promoters intend to give the public research laboratories the possibility of transferring technologies to newly-formed or developing companies and also to provide a high-quality organization for those who wish to invest in public research laboratories.

In Alsace, technology transfer has taken place in several areas: new materials, medicines, laser applications, biotechnology, advanced chemistry, organic chemistry, plastics technology, automation, image transmission, solar conversion, etc. The time has come to give this technology transfer new capital in plant and personnel and thus enable them to create new economic activities. Alsace is putting a lot of hope into them to strengthen its economy.

Also, the departmental expansion committee, Adira, has been sounding out prospects in the United States and has been able to get a feeling for American investors' interest in a multi-purpose research plant. There is a very real interest in French companies developing high value-added business activities.

The Strasbourg ZIRS will be located to the south of the city. It is significant that its first act upon being established will be to plant trees. It will occupy a 200-hectare site near the outskirts of Louis Pasteur University, in Strasbourg (with a college of pharmacy and an institute of technology). The first section of the ZIRS will become visible this year and will occupy 49 hectares. The Strasbourg Urban Community has committed itself to Fr 100 million in financing, which will be supplemented by departmental and regional contributions.

The site master plan calls for an infrastructure of roads, canals (for drainage, quite an original solution), and communications links all combined in the green-belt that will extend from the Rhine River forest nearby.

The initial plans feature a building that will house a GIP [expansion unknown] that is presently being formed and will do research and development for laser applications under the auspices of a Regional Center for Innovation and Technology Transfer (CRITT). The Chamber of Commerce and Industry also intends to establish a data processing center to develop applications for the general public and professionals and also make it possible to expand regional training capacity in this area.

The Strasbourg Urban Community is also ready to finance support buildings in the form of a hotel for new businesses that would provide a place for inventors and innovators and make an array of services available to them. The ZIRS would be reached by a highway with a direct link to the freeway.

The city, department, region, consular company, expansion committee, and Strasbourg regional development company are all cooperating in this undertaking. A joint planning program is being considered. Louis Pasteur University is involved in the operation, and the initial industrial projects are beginning to take shape.

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